ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE

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DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled "**ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE**" submitted towards partial fulfillment of the requirements for the award of **MD in RADIODIAGNOSIS** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Kavita Saggar**, Professor & Head, Department of Radiodiagnosis, **Dr. Kamini Gupta**, Professor, Department of Radiodiagnosis. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my Teachers

&

Family

ABBREVIATIONS

CE-T1FS	Contrast enhanced T1 fat saturation
CHD	Common hepatic duct
CT	Computed tomography
DWI	Diffusion weighted image
ERCP	Endoscopic retrograde cholangiopancreatography
EUS	Endoscopic ultrasound
GB	Gall bladder
IDUS	Intraductal ultrasound
IHBRD	Intrahepatic biliary radical dilatation
LFT’s	Liver function tests
LHD	Left hepatic duct
MDCT	Multidetector computer tomography
MIP	Maximum intensity projection images
MPD	Main pancreatic duct
MRCP	Magnetic resonance cholangiopancreatography
MRI	Magnetic resonance imaging
NPV	Negative predictive value
PPV	Positive predictive value
PSC	Primary sclerosing cholangitis
RHD	Right hepatic duct
RPC	Recurrent pyogenic cholangitis
T2WI	T2 weighted image
USG	Ultrasonography

ABSTRACT

Background: Biliary stricture is a fixed narrowing of a segment of the bile duct that results in proximal biliary dilatation and clinical features of obstructive jaundice. Differentiating malignant from benign stricture is crucial since their treatment and prognosis vary. MRCP is evolving as an effective non-invasive imaging technique for examining patients with biliary diseases. Contrast-enhanced MR imaging with MR cholangiopancreatography offers the most comprehensive evaluation as it helps accurately determine the status of the biliary ductal system by identifying the exact site of the obstruction and the length of the stricture.

Aim: 1) To study the spectrum of causes of biliary stricture. 2)To differentiate benign from malignant bile duct stricture using MR imaging and MRCP. 3) To correlate the imaging findings with ERCP, surgical findings, cytology or histopathology wherever possible**.**

Materials and Methods: Fifty-four patients with clinical and laboratory findings suggestive of biliary obstruction underwent MRI/MRCP. The imaging parameters selected for the characterization of bile duct stricture included: 1) No. of stricture, 2)Site of stricture, 3) Wall thickness, 4) symmetry, 5) Abrupt/Gradual narrowing, 6) Length, 7) Signal intensity of stricture, 8) Diffusion restriction on DW-ADC, 9) Post-contrast enhancement with respect to liver parenchyma. Statistical analysis was done by using the chi-square test and the p-value was calculated.

Results: Among 54 cases, 34 were benign (inflammatory, iatrogenic infective, autoimmune) & 20 were malignant (cholangiocarcinoma, GB malignancy, carcinoma head of pancreas, metastatic deposits, periampullary carcinoma) cases. The diagnostic accuracy of MRCP was evaluated in differentiating malignant from benign biliary stricture in correlation with surgical, ERCP, and histopathological outcomes showing sensitivity 95%, specificity 91.1%, PPV 86.3%, & NPV 96.8%. Abrupt, asymmetric, long segment (>12 mm) narrowing with wall thickness more than 3 mm, hyperintense signal on T2WI and hyperenhancement in relation to liver parenchyma on post-contrast sequence were significantly more common in malignant stricture. Number of stricture and site of stricture did not have a significant role in differentiating the cause of stricture.

Conclusion: MRCP is a non-invasive investigation of choice for suspected biliary obstruction. The preoperative characterization of bile duct stricture is essential for planning surgical strategy, the feasibility of conservative treatment, and avoiding unnecessary surgical interventions.

Keywords: Biliary stricture, MRCP, ERCP.

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INTRODUCTION

BILIARY SYSTEM

The biliary tree can be classified as intra hepatic and extra hepatic bile ducts.

INTRAHEPATIC BILE DUCTS:

The individual biliary drainage system is parallel to portal venous supply.

The right hepatic duct has two major branches: a posterior branch draining the posterior segments (VI and VII), with an almost horizontal course, and an anterior branch[1] draining the anterior segments (V and VIII), with a more vertical course. The right posterior duct usually runs posterior and fuses with the right anterior duct from a left (medial) approach to form the right hepatic duct.

The left hepatic duct is formed by segmental tributaries draining segments II–IV.

The bile duct draining the caudate lobe usually joins the origin of the left or right hepatic duct[1].

The ducts of the left hepatic lobe are more anterior than those of the right lobe. It is important, particularly when contrast cholangiogram is performed because contrast may not opacify independent ducts.

EXTRAHEPATIC BILIARY SYSTEM:

The common hepatic duct is the portion of the bile duct above the cystic duct. It is formed by fusion of the right hepatic duct, which is usually short, and the left hepatic duct, and they usually join up just outside the porta hepatis (±1 cm below the edge of the liver).

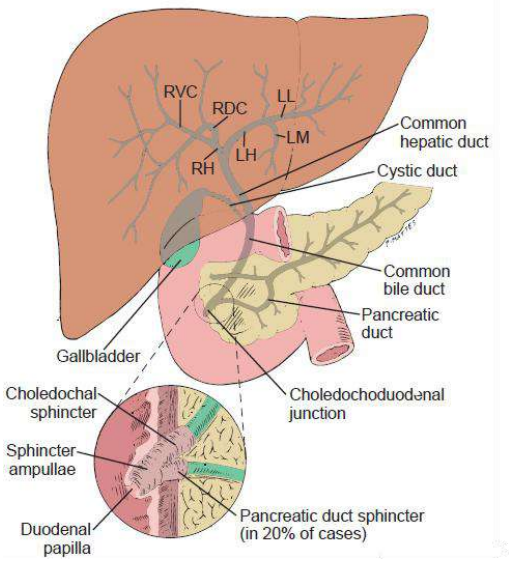
The CHD courses ventrally and inferiorly from the porta hepatis in the hepatoduodenal ligament accompanied by the portal vein, which lies posteriorly, and the hepatic artery, which lies medially. As the CHD passes inferiorly, it angles anteriorly and then posteriorly, crossing over the right portal vein and joining the cystic duct to form the CBD.

The CBD usually divided into suprapancreatic, intrapancreatic, and ampullary segments.

The initial course of the common bile duct course is along the free edge of lesser omentum&enters the head of the pancreas after it passes posterior to the first part of the duodenum in the hepatoduodenal ligament. It passes inferiorly and dorsally, embedded in the posterior surface of the pancreatic head, to join the pancreatic duct of Wirsung. This segment runs a short intramural course before it enters the posteromedial aspect of the duodenum through the major papilla of Vater. The common bile duct is 7 cm long and has an average diameter of 7.4 mm

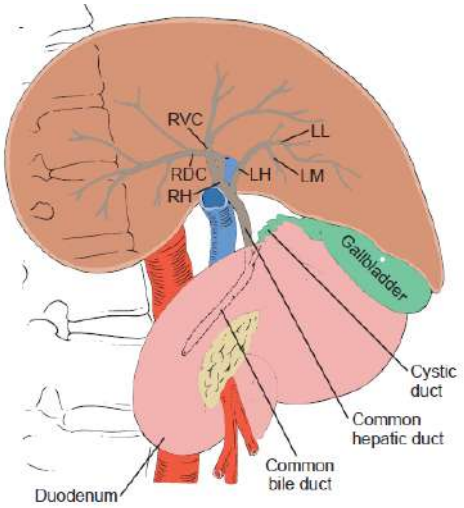
The ampulla of Vater is formed by common bile duct joining with the main pancreatic duct in second part of duodenum.

This normal biliary anatomy is thought to be present in 58% of the population [(1)].



RVC = Right ventrocranial segmental duct
RDC = Right dorsocaudal segmental duct
LL = Left lateral segmental duct
LM = Left medial segmental duct
RH = Right hepatic duct
LH = Left hepatic duct

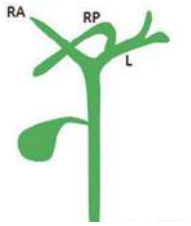
Picture 1: Showing frontal view of normal anatomy of biliary tract[(2)].



Picture 2: Showing parasagittal view of normal anatomy of biliary tract[(2)].

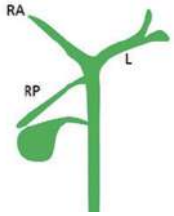
COMMON ANATOMIC VARIANTS OF THE BILIARY TREE

1) The most common anatomic variants in the branching of the biliary tree is the drainage of the right posterior duct into the left hepatic duct before its confluence with the right anterior duct& reported to occur in 13–19% of the population[(1)].



Picture 3: Showing pictorial representation of variant drainage of right posterior duct into left hepatic duct[(3)].

2) In approximately 12% of the population, the right posterior duct will empty into the common hepatic duct[(1)].



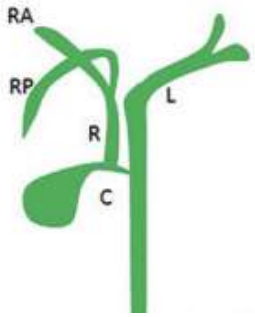
Picture 4: Showing pictorial representation of variant drainage of right posterior duct into common hepatic duct[(3)].

3) Another common variant (11%) of the main hepatic biliary branching is the so-called triple confluence, which is an anomaly characterized by simultaneous emptying of the right posterior duct, right anterior duct, and left hepatic duct into the common hepatic duct[1].

Picture 5: Showing pictorial representation of variant drainage of triple confluence into common hepatic duct[3].

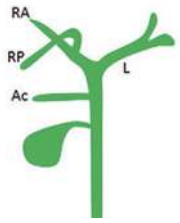
UNCOMMON ANATOMIC VARIANTS OF THE BILIARY TREE

1) Aberrant hepatic duct: has an anomalous confluence pattern &is the only bile duct draining a particular hepatic segment. The direct drainage of the right hepatic duct into cystic duct is present in approximately 2% of the population[1].



Picture 6: Showing pictorial representation of variant direct drainage of right hepatic duct into cystic duct[3].

2) Accessory hepatic duct: is an additional bile duct draining the same area of the liver. It is observed in approximately 2% of patients & may originate from and run their course along both the left or right ductal system[1].

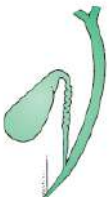


Picture 7: Showing pictorial representation of accessory hepatic duct drainage of right hepatic duct into common hepatic duct[3].

COMMON VARIANTS OF THE CYSTIC DUCT

There are three common variants

1) A low cystic duct insertion, characterized by a fusion of the cystic duct with the distal third of the extrahepatic bile duct (9%)[1].



Picture 8: Showing pictorial representation of low insertion of cystic duct[2].

2) A low medial cystic duct insertion, in which the cystic duct drains into the left side of common hepatic duct in its distal third (10–17%)[1].

Picture 9: Showing pictorial representation of low medial insertion of cystic duct[3].

3) A parallel course of the cystic duct and common hepatic duct - when cystic duct follows a closely adherent course, parallel to the common hepatic duct over at least a 2-cm segment(1.5–25%)[1].

Picture 10: Showing pictorial representation of parallel course of cystic duct and common hepatic duct[3].

UNCOMMON ANATOMIC VARIANTS OF THE CYSTIC DUCT

1) High fusion of the cystic duct with the common hepatic duct.
2) Aberrant fusion of the cystic duct with the right or left hepatic duct.

BILIARY STRICTURE

Biliary stricture is a fixed narrowing of a segment of the bile duct that results in proximal biliary dilatation and clinical features of obstructive jaundice.A wide spectrum of hepatobiliary and pancreatic diseases, both benign and malignant, can result in the development of biliary stricture(4).

Benign biliary strictures have various origins, each with a different natural history and each demonstrating a different response to treatment.

Iatrogenic causes, such as cholecystectomy and orthotopic liver transplantation, are the most common. Postoperative biliary strictures can be further classified as anastomotic or non-anastomotic.

Other causes include inflammatory (Primary and secondary sclerosing cholangitis, acute or chronic pancreatitis), autoimmune or immunoglobulin G4–related cholangiopathy, radiation-induced sclerosing cholangitis, ischemia (Hepatic artery stenosis or

thrombosis), and infections(Recurrent pyogenic cholangitis, human immunodeficiency virus cholangiopathy, tuberculosis, sarcoidosis, parasitic) & miscellaneous (Portal biliopathy, trauma, papillary stenosis).

STRASBERG CLASSIFICATION

It was originally described for laparoscopic injuries of the biliary ducts[5].

1) Type A Leak from the cystic duct or a small duct in the liver bed
2) Type B Occlusion of an aberrant right hepatic duct
3) Type C Transection of an aberrant right hepatic duct without ligation
4) Type D Lateral injury to a major bile duct
5) Type E1 Distal CHD stricture with a CHD stump ≥ 2 cm long
6) Type E2 Proximal CHD stricture with a CHD stump 2 cm long
7) Type E3 Hilar stricture with no CHD stump but with preservation of the hilar confluence
8) Type E4 Hilar stricture with loss of communication between the right and left hepatic ducts
9) Type E5 Aberrant right hepatic duct stricture with or without concomitant CHD stricture

Malignant biliary strictures usually result from local malignancy, most commonly cholangiocarcinoma, pancreatic adenocarcinoma, liver metastases, hepatocellular carcinoma, ampullary carcinoma, or gallbladder adenocarcinoma.

Other causes can include lymphoma and metastasis to the regional lymph nodes.

BISMUTH CLASSIFICATION

The most commonly used classification for stricture due to hilar cholangiocarcinoma.

It is based on the location of the stricture and is used to help surgeons identify the biliary level for repair and anastomosis[5].

1) Type I strictures are located more than 2 cm distal to the confluence of the left and right hepatic ducts.

2) Type II strictures are located less than 2 cm from the hepatic confluence.
3) Type III strictures involve the hepatic confluence but do not affect its patency.
4) Type IV strictures involve the confluence and interrupt it.
5) Type V stricture involves the aberrant right sectoral hepatic duct alone or with concomitant injury of the common hepatic duct.

In a suspected case of biliary obstruction with clinical and laboratory findings suggestive of obstructive jaundice, the main aim of the radiologist is to confirm the presence of obstruction and to identify its location, extent and probable cause.

Differentiation of benign from malignant biliary stricture based on imaging has been one of the challenges for the radiologist.

For the imaging diagnosis of biliary strictures, invasive imaging modalities i.e. direct cholangiography techniques, such as percutaneous transhepatic cholangiography (PTHC) and endoscopic retrograde cholangiopancreaticography (ERCP) usually preceded by noninvasive options to diagnose and characterize biliary strictures. These options, include ultrasonography (US), multidetector CT (MDCT) and MRI with MR cholangiopancreatography.

PERCUTANEOUS TRANSHEPATIC CHOLANGIOGRAPHY:

This requires creation of a parenchymal tract and is typically performed for therapeutic purpose once the decision to perform biliary drainage has been made based on clinical presentation and cross-sectional imaging findings.

The decision to perform PTC using a right- or left-sided approach depends on the location of the biliary stricture (right or left side of the biliary tree).

In the left-sided approach, access to the biliary system is typically obtained with US guidance[5].

For biliary strictures located in the common hepatic duct or the common bile duct, most interventional radiologists prefer to use the right midaxillary approach, as the majority of the liver is drained by the

right-sided ductal system, and the right-sided approach is associated with lower complication rates.

PTC is easier and quicker to perform and is less costly. It has a high success rate; dilated ducts are opacified in virtually 100% and nondilated ducts in 80% to 85% of patients[6,7]. The complication rate is low (3.4%), and the procedure is performed by the radiologist[8].Therapeutic transhepatic options after PTC require a higher skill level. These include biliary drainage; stone extraction, crushing, contact dissolution, laser fragmentation, and contact lithotripsy; stent placement; stricture dilation; and biopsy.

MR CHOLANGIOPANCREATOGRAPHY (MRCP):

Magnetic resonance cholangiopancreatography is a non-invasive imaging technique that uses magnetic resonance imaging as a means to visualize the biliary duct and the pancreatic duct without the need for contrast. This was introduced in 1991, and since then, the spatial resolution of this technique has improved considerably. MRCP functions with heavily T2-weighted sequences and highlights static fluids or fluid filled slow moving structures like the pancreatic and bile duct. The evidence of dilated ducts is increased by adding suppression of the background fat tissue: in this way the dilated biliary or pancreatic ducts are greatly enhanced with respect to adjacent tissues and organs.

Coronal T2-weighted images viewed as thin collimation images (3-5 mm), and it is subsequently processed to obtain a MIP (maximum intensity projection) image which is a cholangiogram like projectional image. Coronal thick slab (30 to 50 mm) can also be obtained, to produce the same effect in a very short time (<5 seconds). Usually both these are obtained to achieve higher accuracy.

Latest magnetic resonance equipment allows us to perform MRCP as fast as within fifteen minutes. At present, MRCP is performed widely as a modality of primary imaging, used in assessing conditions like obstructive jaundice and other pancreatico-biliary duct abnormalities that may be benign or malignant.

Magnetic resonance cholangiopancreatography (MRCP) has become an important diagnostic procedure in evaluation of pancreaticobiliary ductal abnormalities[9]. MRCP offers the advantage of noninvasive imaging without the risk of any procedure-related complications, allows evaluation of the biliary system beyond a tight stricture, and allows assessment of the hepatic parenchyma and other intraabdominal viscera. Magnetic resonance imaging is increasingly being used for cross-sectional imaging of the abdomen in patients with biliary obstruction.It also has distinct advantage of being able to evaluate the biliary enteric anastomosis in the immediate postoperative period. MRCP is highly sensitive for the diagnosis of biliary strictures and is the imaging modality of choice for identifying the level of obstruction. This modality can also delineate recurrence of the primary pathology (e.g., primary sclerosing cholangitis) and complications associated with various pathologic conditions causing biliary stricture such as bile leak and biloma formation following iatrogenic biliary stricture, biliary stasis leading to stone formation and help evaluate progression of benign disease to a malignant condition as seen in cases of primary sclerosing cholangitis.

MRCP is of advantage in identifying distal causes of CBD obstruction as sonography has limitations in the evaluation of the distal CBD which may be obscured by bowel gas and demonstration of biliary strictures.

The advantages of MRCP over MDCT include the lack of ionizing radiation, along with the ability to provide high quality cholangiograms that can determine the location and extent of biliary strictures and help guide endoscopic therapy, particularly when ERCP is indicated[10].

Only central intra-hepatic bile ducts are normally seen on MRCP, usually measuring up to 3 mm in diameter, whilst extra-hepatic bile ducts should not exceed 7 mm. In patients with a previous cholecystectomy, mild biliary dilatation occurs, with the CBD measuring up to 10 mm in diameter.

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY:

Endoscopic retrograde cholangiopancreatography (ERCP) is a technique that combines endoscopy and fluoroscopy for diagnosing and treating biliary or pancreatic ductal abnormalities. An endoscope with a camera and light at the end is inserted through the esophagus, to the stomach and to the duodenum. Contrast media is injected in to the biliary and pancreatic ducts which are visualized on X-rays. ERCP additionally offers therapeutic advantage once the diagnosis is established. Stenting, sphincterotomy or stone removal can be performed in the same sitting. Biopsies can also be taken for tissue diagnosis.Traditionally, endoscopic retrograde cholangiopancreatography (ERCP) has been used to diagnose suspected biliary obstruction, but this technique is invasive[11,12].

Moreover, ERCP only allows the intraluminal assessment of bile duct while, evaluation of the extraluminal soft tissue component is not possible. Contrary to ERCP, 3D-MRCP is a non-invasive diagnostic technique that can depict the anatomy of entire biliary tree, including the obstructed segment as well as the proximal and distal bile ducts.

Due to the risk of acute pancreatitis associated with ERCP, especially in low volume centers, MRCP is preferred for the initial evaluation of patients with biliary stricture. The ability to obtain a cholangiogram without injection of contrast into the biliary tree is significant, since the injection of contrast medium can result in hard-to-treat cholangitis in patients in whom adequate biliary drainage cannot be achieved during ERCP[13].

MRCP is an imaging modality that has constantly evolved & reached a developmental stage where its usefulness has been proven clinically which can be compared to the clinical accuracy of other conventional cholangiography techniques.

MRCP has a high reported sensitivity and specificity, similar to that of ERCP, for assessing the level and morphology of biliary stricture[14,15].

MRCP can also help in differentiating malignant from benign stricture, with a reported sensitivity of 38–90% and specificity of 70–85%[16,17].

The combination of different imaging sequences influence the diagnostic capability of MR examination. Conventional T1- and T2-weighted images allow evaluation of extraductal soft tissue, which may increase the diagnostic accuracy by demonstrating extension of tumor, lymphadenopathy, or metastasis in addition to depiction of tumoritself[13].

In this study we determined the value of conventional T1- and T2-weighted images and gadolinium-enhanced MR images(wherever indicated) with MRCP images in differentiation of benign from malignant biliary stricture.

AIMS AND OBJECTIVES

1. To study the spectrum of biliary strictures.
2. To differentiate benign from malignant biliary stricture using MR imaging and MRCP.
3. To correlate the imaging findings with endoscopic, ERCP, EUS, surgical findings, cytology or histopathology wherever possible.

REVIEW OF LITERATURE

According to Soto JA et al (1996) Magnetic resonance cholangiography (MRC) is an efficient noninvasive diagnostic imaging modality which provides high quality images of the biliary ducts. Forty-six patients were referred for elective direct cholangiography out of which 45 patients underwent endoscopic retrograde cholangiopancreatography and one patient underwent percutaneous transhepatic cholangiography. Biliary ductal abnormalities such as presence of dilatation, strictures, and intraductal abnormalities were assessed. MRCP was evaluated comparing with direct cholangiography as the gold standard and the sensitivity and specificity images were obtained in total number of 44 patients. Sensitivity for diagnosing biliary ductal dilatation (n = 27), bile duct strictures (n = 10), and intraductal pathologies (n = 7) were calculated and it was 96.3%, 90%, and 100%. Therefore, they opined that MRC has extremely high sensitivity and specificity in evaluating the biliary tree[18].

Hintze RE et al (1997) evaluated clinical importance of MRCP compared to ERCP. A total of 78 patients were prospectively followed up with ERCP and MRCP for aduration of twelve months. The sensitivity of MRCP in detecting normal bile ducts was found to be 71%, bile duct dilatation was 83%, and stricture was 85%, correct stricture location in 77% and bile duct calculi was 80%. The positive predictive value of MRCP for normal bile ducts was 62%, bile duct dilatation was 91%, strictures was 100%, correct stricture location was 91% and bile duct calculi was 100%. The MRCP's sensitivity in detecting malignant strictures 80%. Thus he concluded that MRCP is equivalent to ERCP in terms of contributing diagnostic information in many patients[19].

Lee et al., (1997) in their study found level of obstruction was accurate in 91% (21 of 23) with MR cholangiopancreatography and in 83% (19 of 23) with ERCP (P > .05). The sensitivity, specificity, and accuracy in distinguishing malignant from benign lesions were 81%, 92%, and

87%, respectively, for MR cholangiopancreatography and 71%, 92%, and 83%, respectively, for ERCP[20].

Vitellas KM et al (2000) in his study proved MRCP as an equally comparable investigation tool in diagnosing extrahepatic bile duct abnormalities when compared with invasive diagnostic endoscopic retrograde cholangiopancreatography (ERCP). In MRCP, due to sclerosing cholangitis, benign structures appear as multifocal segments of dilatation and narrowing or bile ducts of normal-caliber, which produces a classic beaded appearance. Features such as bile duct dilatation and pancreatic duct dilatation in MRCP is highly in favor of malignancy of pancreatic head. In patients in whom biliary-enteric anastomoses is present, MRCP is considered to be the imaging investigation of choice in the evaluation of any patient with suspected pancreatico-biliary disease. Another significant MRCP's use, is its capability in demonstrating the abnormal anatomy of the bile duct before performing cholecystectomy[21].

According to Angulo P et al (2000) MRCP had a significant role in diagnosis. In this study, invasive cholangiography such as PTC or ERCP, and MRC were performed in 73 patients. Out of the total study population of 73 patients, 42 patients had benign biliary disease, out of which 23 patients had primary sclerosing cholangitis; 9 patients were diagnosed with malignant biliary disease; and the remaining 22 patients had normal biliary ducts. MRC was obtained in 73/73 (100%), and invasive cholangiography (2 PTC's, 68 ERCP's) procedures in 70/73. Using findings of ERCP/PTC as the standard, MRC was assessed and diagnostic accuracy was found to be greater than 90% in the diagnosis of biliary ductal dilatation, bile duct stones, biliary obstruction, normal biliary tree and primarysclerosing cholangitis. Therefore he proved MRC has significant diagnostic accuracy of 90% in diagnosing biliary abnormalities compared to the invasive cholangiography in which diagnostic accuracy came up to 97%[22].

Lopera et al. in their study (2001) using direct cholangiography as the standard of reference, reported that MR cholangiography was adequate in helping predict the Bismuth grade of biliary ductal involvement in 96% (28 of 29) of the patients. MR cholangiography was adequate to define the extent of biliary ductal involvement in patients with malignant hilar and perihilar biliary obstruction and unresectable disease. On the basis of MR cholangiography findings, a management strategy can be planned, including selection of the most appropriate side for access to the biliary ductal system and the type of biliary drainage required. MR cholangiograms alone can be used for planning palliative percutaneous therapy[15].

In a study conducted by Taylor AC et al, (2002), they prospectively assessed the accuracy of MRCP in 146 patients. They found that the sensitivity, specificity, positive and negative predictive values for MRCP in the diagnosis of Choledocholithiasis were 97.9%, 89.0%, 83.6% and 98.6% respectively. The sensitivity and specificity in diagnosing strictures by MRCP were 100% and 99.1%. They concluded that MRCP is an accurate, noninvasive alternative to ERCP for imaging the biliary tree[23].

According to Tripathi RP et al (2002) MRCP was found to have high sensitivity and specificity in detecting biliary abnormalities such as biliary dilatation, bile duct calculi, strictures and their anatomical variants. MRCP has now extremely improved in its diagnostic efficacy with its increased resolution and reliability to an extent that it can replace diagnostic ERCP. The MRCP results were analyzed in patients with pancreatic and biliary ductal abnormalities, and these findings were compared with surgical findings or with the finding of ERCP. The results were favoring MRCP as it correctly identified the biliary obstruction level in 58 patients out of the total 61 patients. It was possible to characterize the nature of stricture whether it was benign or malignant in 30 patients out of 32 patients[24].

In another study, Park et al., (2004) concluded that MR Cholangiopancreatography is comparable to ERCP in differentiating extrahepatic bile duct cholangiocarcinoma from a benign stricture and showed that a lengthy narrowed segment with irregular margins and asymmetric narrowing is suggestive of malignancy .They found that the sensitivity, specificity, and accuracy of MRCP for differentiation of malignant from benign causes of biliary stricture were 81%, 70%, and 76% respectively[(25)].

Domagk et al.,(2004) showed that diagnostic image quality for ERCP was 88% and 76% for MRCP ($p > 0.05$). Comparing ERCP and MRCP, complete presentation of the biliary tract was achieved in 94% and 82%, respectively ($p > 0.05$). ERCP and MRCP allowed correct differentiation of malignant from benign lesions in 76% and 58% ($p= 0.057$), respectively. By supplementing ERCP with IDUS, the accuracy of correct differentiation of malignant from benign lesions increased significantly to 88% ($p= 0.0047$). ERCP supplemented by IDUS gives more reliable and precise information about differentiation of malignant and benign lesions than MRCP alone without additional imaging sequences[(26)].

Miletić D et al (2007) in their study assessed that Magnetic resonance cholangiopancreatography (MRCP) had extremely high sensitivity and specificity in demonstrating the level and identifying the presence of biliary duct obstruction. One major weakness of MRCP is its inability to offer therapeutic interventions. Other significant advantage of MR cholangiography is that it can also be used for detecting the resectability of a malignant neoplasm such as hilar cholangiocarcinoma by assessing the proximal extent of disease where ERCP may not be successful[(27)].

According to Halefoglu AM et al(2007) MRCP has a much lower complication rate when compared to ERCP. As already proved ERCP is considered as the gold standard investigation for biliary tract imaging but is less invasive and is also associated with complications[(28)].

Kim et al., (2007) showed that a narrowed segment with the following MR imaging features is more likely to be malignant: hyperenhancement relative to the liver during the portal venous phase, length of over 12 mm, wall thickness greater than 3 mm, indistinct outer margin, luminal irregularity, and asymmetry[29].

Saluja et al., (2007) suggested in their study that malignant strictures were irregular with an asymmetric dilatation because of the nature of involvement of the bile duct by the malignant tumor. They found sensitivity, specificity and diagnostic accuracy of MRCP for biliary obstructive diseases in their study to be 87.5%, 85.3% and 82.7% respectively[16].

In the study by Zidi et al, (2007) MR cholangiography was compared with endoscopic retrograde cholangiopancreatography in patients with hilar strictures; MR cholangiography enabled correct classification of the severity of involvement in 14 (78%) of 18 patients. The usefulness of MR cholangiography in accurate demonstration of the extent of hilar involvement has important implications for therapeutic planning[30].

Huang LY et al (2009) assessed the application of ERCP in biliary ductal and pancreatic diseases. He included a total number of 2075 patients who underwent ERCP and their results were analyzed retrospectively. He also calculated the complications and the therapeutic effect of ERCP. In 64 cases, diagnostic ERCP was performed and the procedure was successful, in the remaining 2011 cases therapeutic ERCP was performed, and the success rate came up to 94.6%. Complication rates were assessed which came up to 5.1% and the most common complication detected was acute pancreatitis. With these above findings, he came to a conclusion that ERCP can be considered as the major diagnostic and therapeutic tool for biliary ductal and pancreatic disease. Therapeutic ERCP has advantages like it is a minimally invasive procedure, safe and acts as an effective treatment method for biliary-pancreatic diseases[31].

In the study done by Rahman R et al (2010) of 165 patients who underwent MRCP prior to ERCP the sensitivity and specificity of MRCP

was calculated and was found that MRCP did not show satisfying result when compared with that of ERCP in diagnosing choledocholithiasis, biliary and pancreatic ductal dilatation or obstruction and periductal masses. MRCP showed 74.6% sensitivity and 83.5% specificity in detecting choledocholithiasis, 85.4% sensitivity and 87.4% specificity in detecting strictures, 85.9% sensitivity and 91.2% specificity in detecting obstruction, 92.4% sensitivity and 93.5% specificity in detecting ductal dilatation, and 90.8% sensitivity and 92.6% specificity in detecting periductal masses. The study shows MRCP to have increased false negative results in case of choledocholithiasis and strictures and increased false positive results in case of ductal dilatation and periductal mass when compared with ERCP. Therefore, itcannot be used as a substitute, thereby ERCP remains the gold standard investigation for better visualization of the biliary tree and pancreatic duct[32].

Accuracy of magnetic resonance cholangiopancreatography was assessed by Liang C et al (2011) in patients with malignant obstructive jaundice. They proved the diagnostic efficacy in determining the location and extent of obstruction using MRCP was higher and the specificity was 82.9%. Liang C, Mao H analyzed accuracy of MRCP in diagnosing malignant obstructive jaundice. The diagnostic accuracy of MRCP in malignant obstruction came up to 82.9%. Hence MRCP was proved to have high diagnostic specificity in identifying the location and also the extent of obstruction. They concluded saying that MRCP had significant role in diagnosing malignant obstructive jaundice[33].

A study done by Bilgin M et al (2012), to investigate the diagnostic efficacy of dynamic contrast enhanced (MRI) method in patients with bile duct obstruction, it was observed that MRI/MRCP had sensitivity(96%), specificity (100%) and accuracy (96.3%). In determination of presence of level of obstruction (96.7%, 100%, 97.2%), choledocholithiasis (82.3%, 96%, 91.7%) stenosis (95.6%, 91.3%, 94.5%). It was concluded that, MRI/MRCP is a non-invasive imaging method with high accuracy rates in the evaluation of

obstructive biliary tract pathologies which might replace the diagnostic ERCP[34].

Yu et al (2014), reported that malignant strictures were significantly thicker and longer than the benign strictures and upstream CBD dilatation was larger in the infiltrative cholangiocarcinoma cases than in the benign cases[35].

Katabathina et al., (2014) in their study found that benign strictures showed a short-segment smooth stricture of the CHD or CBD with associated intrahepatic biliary dilatation on MR Cholangiopancreatography(4).

Amandeep Singh et al (2014) in their study reported diagnostic accuracy of MRCP (98%) in the diagnosis of benign and malignant diseases was relatively high (98% and 98%) as compared to CT (82.86% and 91.43% in benign and malignant respectively) and USG (88% and 88%). In the diagnosis of benign diseases MRCP was 100% sensitive compared to ultrasound (80.77%), which was more sensitive than CT scan (54.55%) in the diagnosis of malignant diseases, MRCP was more sensitive (95.83%) as compared to CT scan (91.67%), which was more sensitive than ultrasonography (79.17%). MRCP is an important non-invasive imaging investigation in the pre operative evaluation of patients with obstructive jaundice[36].

Meena Suthar et al (2015) evaluated 75 cases of obstructive jaundice, out of which, there were 54 benign and 21 malignant cases. Mean age of patients with malignant obstruction was more than benign with slight male preponderance. The diagnostic accuracy of MRCP in differentiating benign from malignant biliary obstructive diseases in correlation with surgical, ERCP and histopathological outcome was 93.3%, sensitivity 85.7%, specificity 96.3%. It was found that irregular, asymmetric and long segment narrowing was more common in malignant stricture[37].

Parashari UC et al., (2015) identified the cause of biliary obstruction in 50 patients found to have biliary obstruction out of 54 patients. The cause of biliary obstruction was finally identified on the basis of direct

cholangiography/surgery/histopathology. In 52 of the 54 patients, MRCP agreed with final diagnosis in identifying the level of block. MRCP agreed with final diagnosis in identifying the cause of obstruction in 48 of the 54 patients (89%). Sensitivity of MRCP in identifying the level of obstruction in comparison with final diagnosis was 100%, while diagnostic accuracy of MRCP in identifying the level of obstruction in comparison with final diagnosis was 96.29%. The correlation between MRCP and final diagnosis in diagnosing cause of obstruction was 0.95 (Pearson's correlation coefficient, P = 0.017)[38].

Shabanikia et al(2021) in their study showed that MRCP is a sensitive method to differentiate malignant lesions from benign pathologies. A long and thick stricture with the presence of a solid mass, upstream biliary duct dilation, and abrupt tapering is highly suggestive of malignancy. Out of 50 patients, 23 patients (46%) had malignant strictures based on MRCP and histopathology. The sensitivity and specificity of MRCP to detect malignancy were 95.7% and 96.3%, respectively. The most sensitive MRCP features to detect malignancy were upstream biliary duct dilation, abrupt tapering, and the presence of a solid mass with sensitivity 100%, 95.7%, and 78.2%, respectively. The malignancy rate was significantly higher in the strictures with length >11.5 mm or wall thickness >2.75 mm ($P < 0.05$)[39].

MATERIALS AND METHODS

Source of Data

This longitudinal prospective study was done on patients who underwent MRI and MRCP for suspected biliary obstruction, at the Department of Radiodiagnosis, Dayanand Medical College & Hospital, over a period of one year from 1 March 2021- 28 February 2022. All the patients were imaged using MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Siemens, Germany.

METHOD OF COLLECTION OF DATA

Patients who had clinical and laboratory parameters suspicious of biliary obstruction and referred to the department of radiodiagnosis were included in the study. Informed consent was obtained from each patient and relevant detailed history collected and recorded in the proforma. Before starting MRI study, the procedure was explained to the patients in his/her vernacular language to allay anxiety and fear.

INCLUSION CRITERIA:

All patients found to have biliary stricture on MRI and MRCP.

EXCLUSION CRITERIA:

- Patients with prior history of biliary surgery except cholecystectomy.
- Anyone who is unwilling to participate in the study.
- Any contraindications to contrast administration (GFR < 30ml/min).

MR imaging technique

All patients underwent a multiplanar, multisequential MR imaging of upper abdomen on a MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Siemens, Germany.

Following MR imaging sequences were included:

1. T2 haste axial
2. T2 haste fat sat axial
3. T2 haste coronal
4. T2 trufi axial

5. T1 VIBE in-out phase axial

6. Diffusion Weighted Imaging(DWI) in axial plane acquired at 3 b-values of 50, 400, 800.

7. T2 TSE 3D coronal.

8. Contrast Enhanced MRI

Contrast Enhanced MRI will be performed using three-dimensional volume interpolated breath hold examination (3D VIBE) sequence in the transverse planewas performed only in patients where it was clinically indicated.

A rapid bolus of 0.1mmol/kg body weight gadobenatedimeglumine was injected through a peripheral vein followed by 10 ml of saline. Images were acquired in arterial, portal and venous phase.

Image and data analysis

The biliary tree was evaluated for its caliber, variant anatomy if any and presence of stricture/strictures.

The following features of biliary stricture evaluated:

1. Site of stricture – Intrahepatic, CHD, Suprapancreatic CBD, Intrapancreatic CBD.
2. Number of stricture(s) – Single/ Multiple,
3. Symmetry/Asymmetry
4. Wall thickness
5. Narrowing – Abrupt/ Gradual
6. Wall signal – Hyperintense/ Hypointense/ Isointense in relation to liver parenchyma
7. Wall enhancement relative to liver parenchymal enhancement
8. Length of stricture
9. Diffusion pattern

Associated findings were also recorded which included any lesion in liver, h/o cholecystectomy, GB mass, changes of chronic pancreatitis in form of ductal irregularity & dilatation, focal lesion involving head of pancreas, prior h/o inflammatory bowel disease.

Duration of Study: One year from 1st March 2021 to 28th Feb 2022.

Outcome: Analyzed the MRCP findings for the spectrum of biliary stricture and classifying the biliary stricture into benign and malignant on the basis of their morphological characteristics and their correlation with ERCP, surgical, cytology or histopathological findings wherever possible.

STATISTICAL ANALYSIS:

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate.

For comparing categorical data, Chi square ($\chi 2$) test will be performed and exact test was used when the expected frequency is less than 5.

A probability value (p value) less than 0.05 will be considered statistically significant. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) SPSS 21 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

Table 1: MRI Acquisition parameters.

	TR	TE	FOV (R)	FOV (P)	SLICE	SLICE THICK	GAP	FLIP ANGLE	FAT SAT	MATRIX	FLOW COMP	PHASE ENC	ORIENTATION
T1 vibe Fat Sat	3.31 ms	1.3 ms	380 mm	81.3%	72	3 mm	1.1 mm	9^0	SPAIR	182*320	NO	AP	Transverse
T1 vibe In-out phase	4.34 ms	1.34, 2.76 ms	380 mm	81.3%	72	3 mm	1.1 mm	9^0	NONE	182*320	NO	AP	Transverse
T2 haste fat sat	2000 ms	91 ms	350 mm	78.1%	30	5 mm	2.5 mm	160^0	SPAIR	200*320	NO	AP	Transverse
T2 haste traction	2000 ms	91 ms	360 mm	78.1%	30	5 mm	2.5 mm	160^0	NONE	200*320	NO	AP	Transverse
T2 haste coronal	2000 ms	91 ms	350 mm	100%	35	5 mm	0.5 mm	160^0	NONE	288*320	NO	R-L	Coronal
T2 haste thick slab	4500 ms	734 ms	260 mm	100%	1	50 mm	2.5 mm	180^0	FATSAT	314*448	NO	R-L	
Diffusion	5700 ms	48 ms	380 mm	80.6%	30	5 mm	2.5 mm		SPAIR	108*134		AP	Transverse
T2 TSE 3D CORONAL	1600 ms	623 ms	335 mm	100 %	64	1.5 mm	0 mm	180^0	NONE	320*320	NO	R-L	Coronal
T2 haste coronal thin slab	2000 ms	101 ms	350 mm	100%	30	3 mm	0.2 mm	160^0	SPAIR	205*256	NO	R-L	Coronal
T2 Trufi Axial	382 ms	1.68 ms	380 mm	80.5%	30	5 mm	2.5	50^0	None	206*256		AP	Transverse

OBSERVATION & RESULTS

1. Demographic data:

54 patients were scanned from March 2021 to February 2022. The age range of patients was from 23-80 years, including 16 females & 38 males as shown inTable2 & figure 1.

Table 2: Showing age & gender distribution.

AGE GROUP (years)	TOTAL	SEX			
		FEMALE		MALE	
		NO.	Percentage	No.	Percentage
21-30	6	1	6.2	5	13.1
31-40	4	1	6.2	3	7.9
41-50	8	2	12.5	6	15.8
51-60	20	7	43.8	13	34.2
61-70	10	3	18.8	7	18.5
71-80	6	2	12.5	4	10.5
TOTAL	54	16	100	38	100

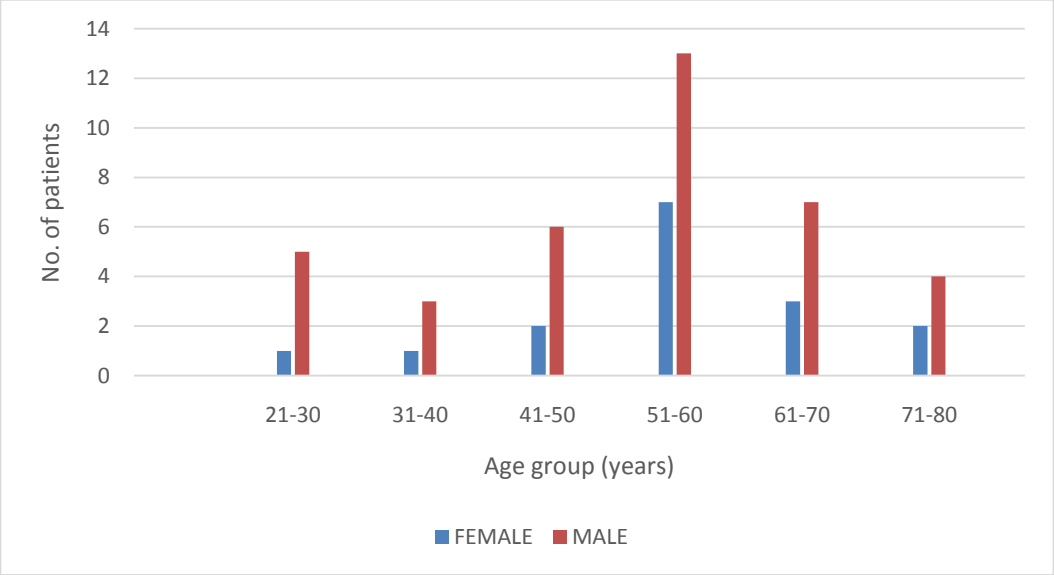


Figure 1: Showing age distribution with number of cases.

All the patients in our study had clinical features of biliary obstruction & were imaged by conventional MRI & 3D MRCP.Final diagnosis in present study was based on surgical / histopathological / ERCP /cytology findings. MR & MRCP findings were then correlated with final diagnosis and diagnostic effectivity of MRCP was calculated for individual parameter and for overall diagnostic performance of MRCP for accurately diagnosing the etiology of biliary strictures. All patients tolerated MRI examination without any adverse reaction to contrast media wherever administered.

Out of these, 34 (62.9%) strictures were benign and 20 (37.1%) were malignant in nature as shown in figure 2.

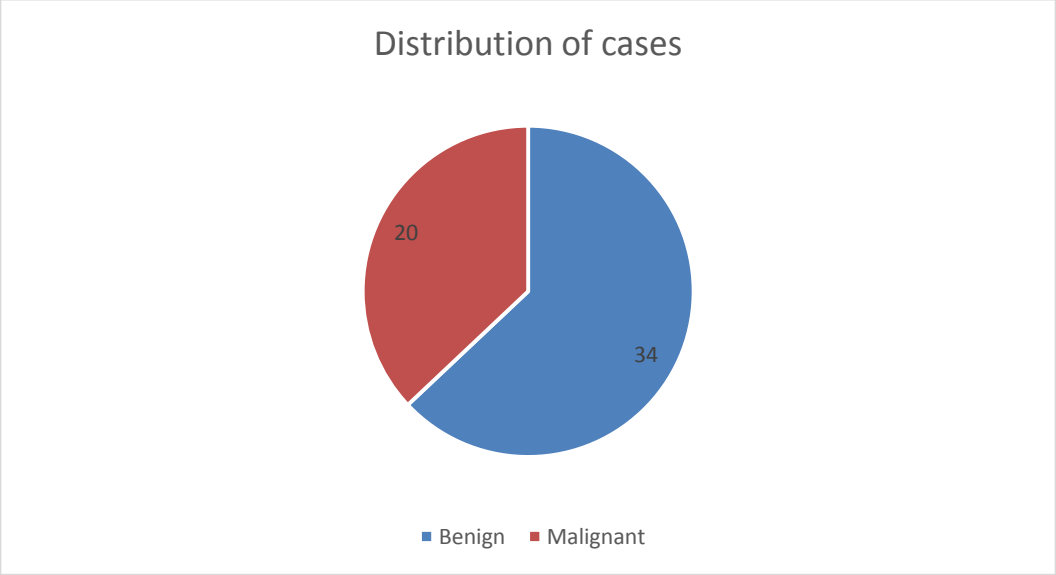


Figure 2: Showing number of benign & malignant cases.

The most common cause of benign stricture (n=34) in present study was inflammatory stricture including primary sclerosing cholangitis &chronic pancreatitis n = 22 (64.7%), followed by iatrogenic (post-cholecystectomy) strictures n=5 (14.3%). Other benign causes were infective (recurrent pyogenic cholangitis & HIV cholangiopathy n=5 (14.5%), autoimmune (IgG4 related) disease n=2(5.8%)as shown in table3and figure 3.

Table3: Etiology of benign stricture in the study population.

	No. Of Patients	Percentage (%)
Inflammatory (PSC & chronic pancreatitis)	22	64.8
Iatrogenic (Post cholecystectomy)	5	14.7
Infective (RPC & HIV cholangiopathy)	5	14.7
Autoimmune (IgG4 related)	2	5.8
Total	34	100

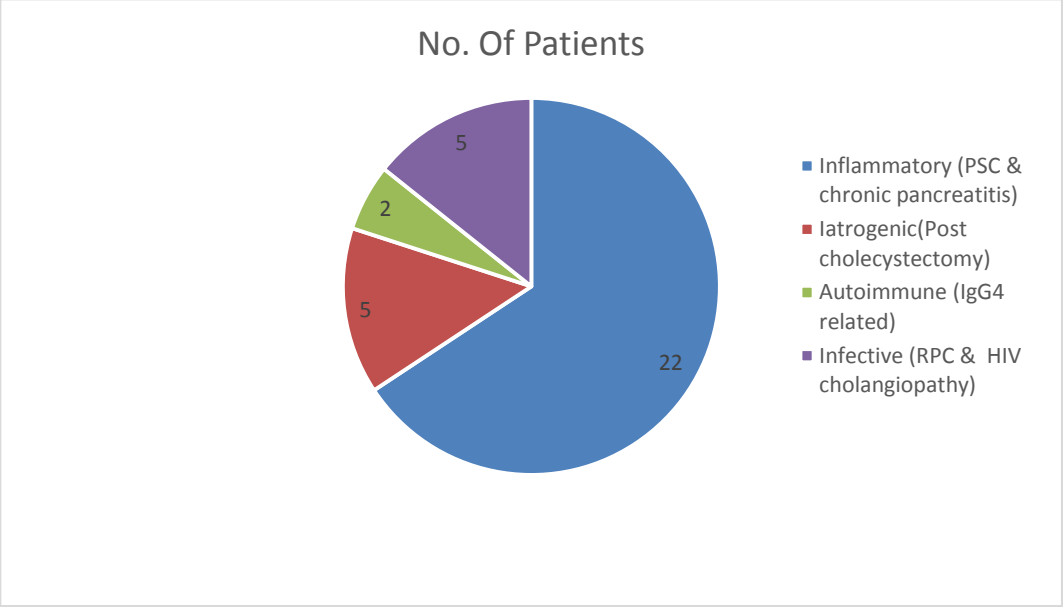


Figure 3: Demonstrating various etiologies of benign stricture.

Out of 20 malignant stricture, GB malignancy was the most common cause n=7(35%) followed by pancreatic head/ periampullary carcinoma n= 6(30%). Other causes were cholangiocarcinoma n=4 (20%) cases, metastatic/ lymph nodal deposits n=3(15%) as shown intable4 & figure 4.

Table 4:Etiology of malignant stricture(s) in study population.

	No. Of Patients	Percentage(%)
GB malignancy	7	35
Pancreatic head malignancy/ Periampullary carcinoma	6	30
Cholangiocarcinoma	4	20
Metastatic / lymph nodal deposits	3	15
Total	20	100

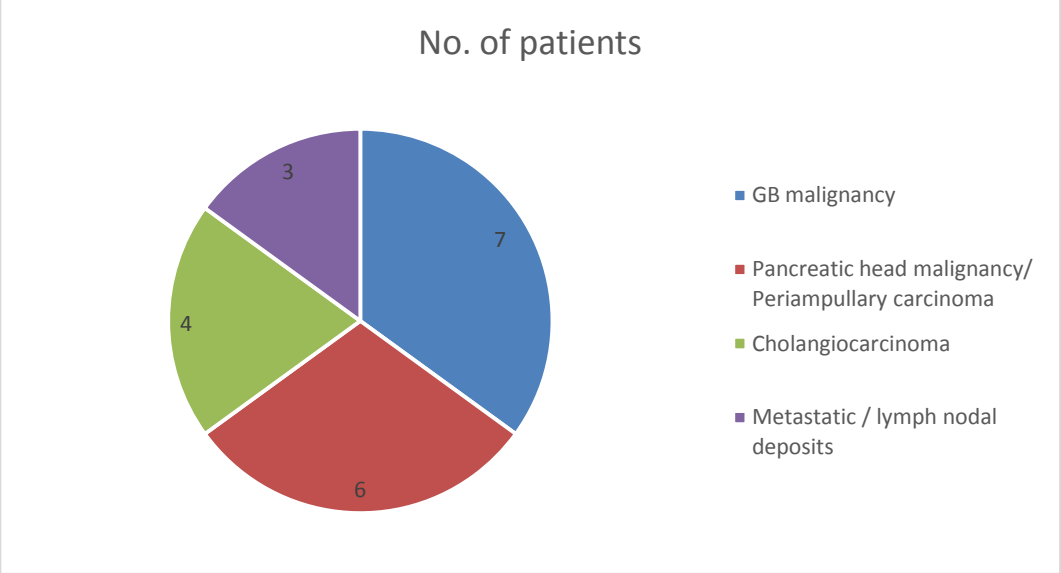


Figure 4: Demonstrating various etiologies of malignant stricture.

2. STATISTICAL ANALYSIS OF MRCP PARAMETERS &CORRELATION WITH FINAL DIAGNOSIS (ERCP/Cytology/Surgical/Histopathological)

2.1) WALL THICKNESS

The mean wall thickness in our study was 2.36 ± 1.31 mmwhich wassignificantly higher among patients with malignant stricture (p< 0.05). Using ROC curve analysis, malignancy was more frequent in strictures with wall thickness >3 mm (p-0.001, AUC = 0.96, 95% CI = 0.00–1.00) as shown in figure 5.

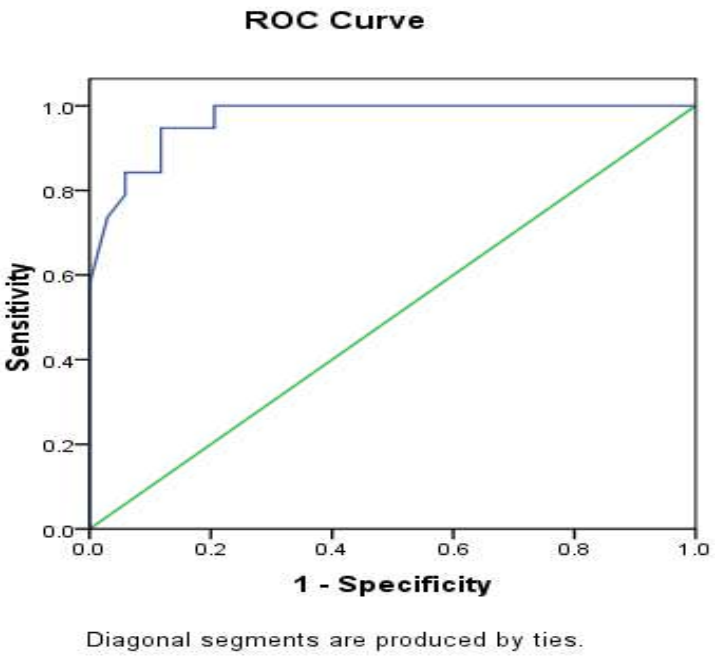


Figure 5: Showing Receiver operating characteristic cure analysis for wall thickness in distinguishing malignant strictures from benign stricture.

In our study, wall thickness of >3 mm was seen in 15out of 20 malignant cases while 5malignant stricture had wall thickness of < 3 mm.

Wall thickness of < 3 mm was seen in 33out of 34 benign cases. Only 1 benign stricture showed thickness >3 mm as shown in Table5 & figure 6.

Table 5: Distribution of number of cases into benign & malignant category on basis of wall thickness (n = 54).

Wall thickness	Malignant	Benign	Total
> 3 mm	15	1	16
< 3 mm	5	33	38
Total	20	34	54

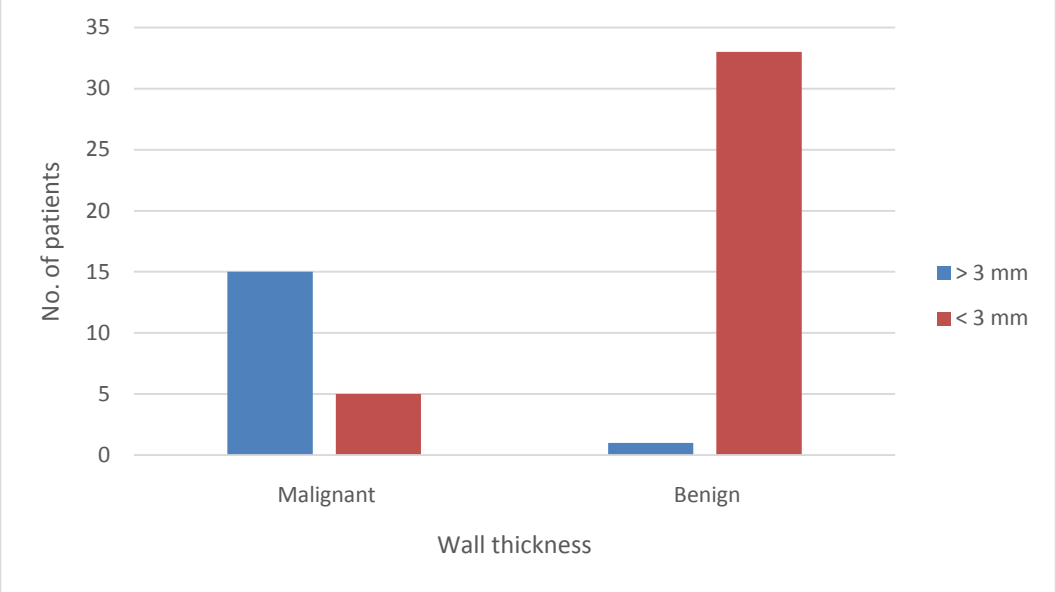


Figure 6: Shows distribution of cases on basis of wall thickness.

Table 6: Diagnostic efficacy of wall thickness> 3mm for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p-value
75%	97%	93.7%	86.8%	0.001

2.2) ASYMMETRIC / SYMMETRIC WALL THICKENING

In our study, asymmetric wall thickening was seen in 18 out of 20 malignant strictures while 2 malignant stricture showed symmetric wall thickening.

Symmetric wall thickening was seen in 32 out of 34 benign strictures. Only 2 benign cases showed asymmetric wall thickening as shown in table 7 & figure 7.

Table 7: Distribution of number of cases into benign & malignant category on basis of asymmetric/symmetric wall thickening (n = 54).

Wall thickening	Malignant	Benign	Total
Asymmetrical	18	2	20
Symmetrical	2	32	34
Total	20	34	54

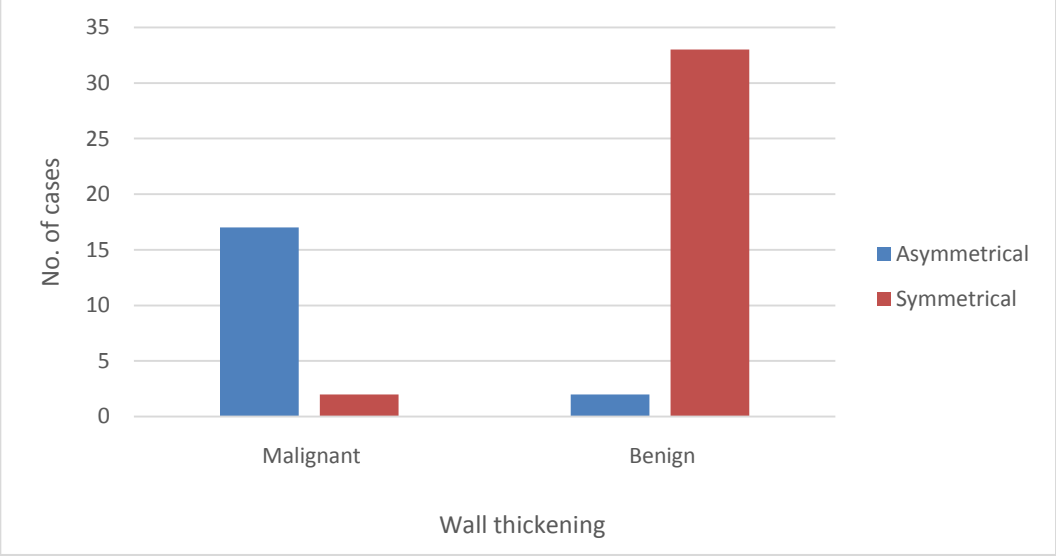


Figure 7: Shows distribution of cases on basis of asymmetric / symmetric wall.

Table 8: Diagnostic efficacy of asymmetric wall thickening for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p-value
90%	94.1%	90%	94.1%	0.001

2.3) SIGNAL INTENSITY OF STRICTURE WALL

In our study, T2 hyperintense signal intensity of the stricture wall suggested malignancy & was seen in 13 out of 20 malignant cases.

T2 Hypointense / isointense signal intensity of the stricture wall was seen in 32 out of 34 benign cases. Only 3 benign cases showed hyperintense signal as shown in table 9 & figure 8.

Table 9: Distribution of number of cases into benign & malignant category on basis of T2 signal intensity of wall thickening (n=54).

Signal Intensity of stricture wall	Malignant	Benign	Total
T2 Hyperintense	13	3	16
T2 Hypo/iso-intense	7	31	38
Total	20	34	54

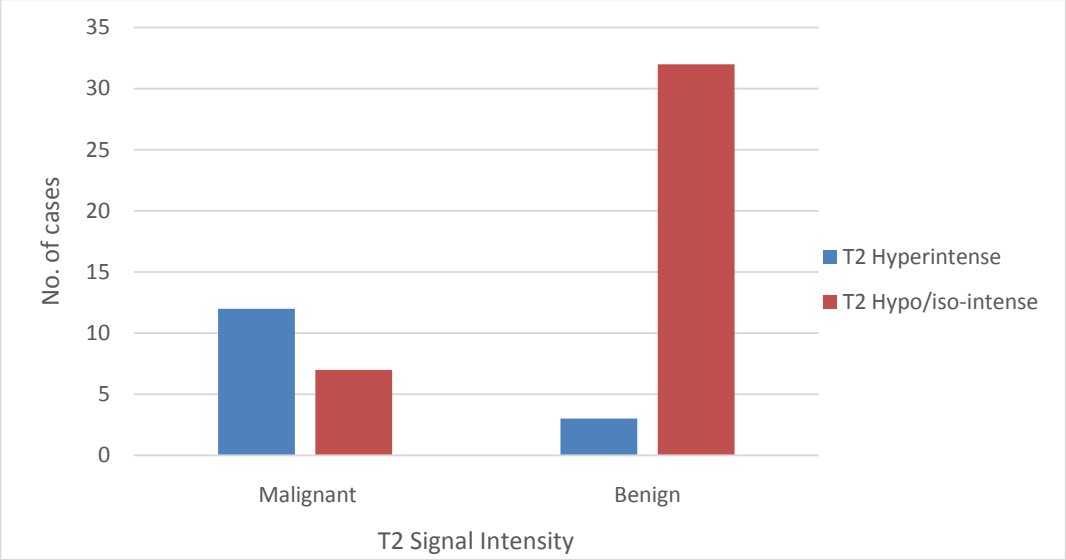


Figure 8: Shows Distribution of cases on basis of signal intensity of stricture wall.

Table 10: Diagnostic efficacy of signal intensity of stricture wall for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p-value
65%	91.1%	81.2%	81.5%	0.001

2.4) ZONE OF TRANSITION

In our study, abrupt zone of transition was seen in all of the20 malignant strictures.

21 out of 34 benign casesalso showed abrupt zone of transition while13 out of 34 benign cases demonstrated gradual zone of transition as shown in table 11 & figure 9.

Table 11: Distribution of number of cases into benign & malignant category on basis of zone of transition (n = 54).

Zone of transition	Malignant	Benign	Total
Abrupt	20	21	41
Gradual	0	13	13
Total	20	34	54

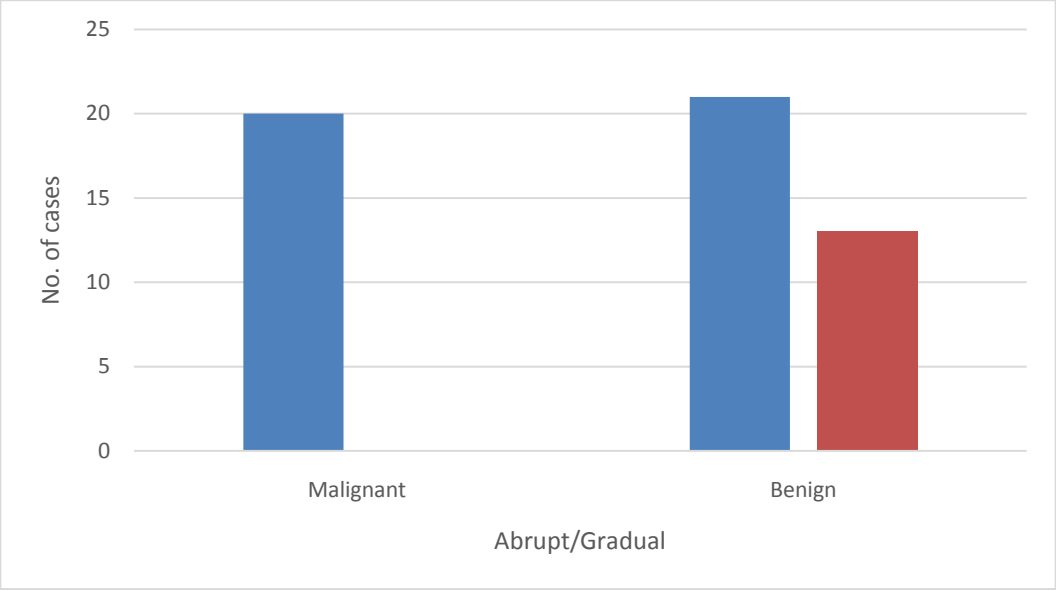


Figure 9: Shows distribution of cases on basis of zone of transition.

Table 12: Diagnostic efficacy of zone of transition for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p-value
100%	38.2%	48.7%	100%	0.002

2.5) LENGTH OF STRICTURE

The mean length of stricture in our study was 13.44 ± 6.36 mm which was significantly higher among patients with malignant tumors (*P* < 0.05). Using ROC curve analysis, malignancy was more frequent in strictures with length more than 12 mm (*P* -0.001,AUC = 0.78, 95%CI = 0.63–0.90) as shown in figure 10.

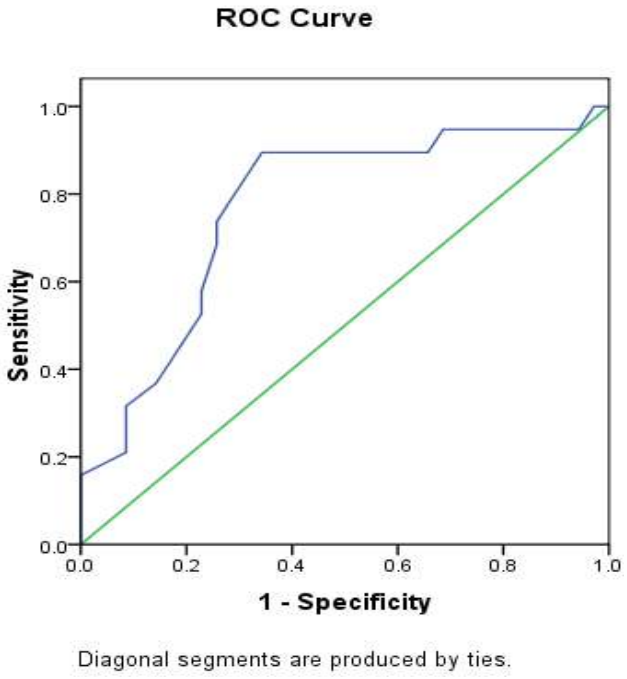


Figure 10: Showing Receiver operating characteristic cure analysis for length of stricture in distinguishing malignant strictures from benign stricture.

Length of stricture >12 mm was seen in 17 out of 20 malignant cases while in 3 out of 20 malignant stricture, it was <12 mm

Length of stricture <12 mm was seen in 25 out of 34 benign cases.9 out of 34 benign stricture showed length >12 mm as shown in table 13 & figure 11.

Table 13: Distribution of number of cases into benign & malignant category on basis of length of stricture (n=54).

Length of stricture	Malignant	Benign	Total
>12 mm	17	9	26
<12 mm	3	25	28
Total	20	34	54

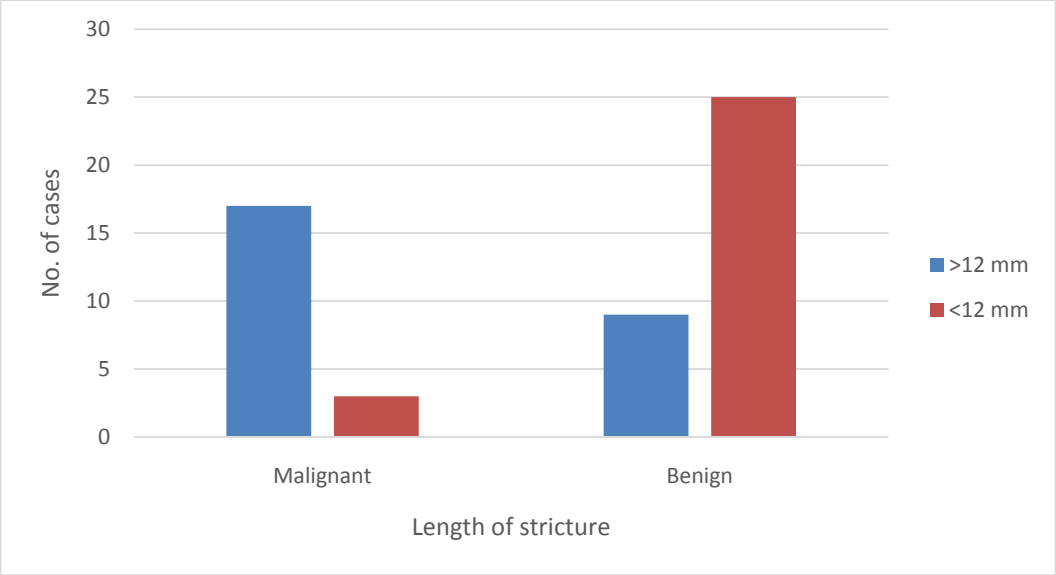


Figure 11: Showing distribution of cases on basis of length of stricture.

Table 14: Diagnostic efficacy of length of stricture>12 mm for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p- value
85.0%	73.5%	65.3%	89.2%	0.001

2.6) DIFFUSION RESTRICTION

In our study, presence of restricted diffusion in the wall was assessed in n = 54 cases. Among which15 out of 20 malignant stricture showed restricted diffusion while only 2 out of 34 benign cases showed diffusion restrictionas shown in table 15 & figure 12.

Table 15: Diagnostic efficacy of diffusion restriction for characterization of malignant bile duct stricture.

Diffusion restriction	Malignant	Benign	Total
Present	15	2	17
Absent	5	32	37
Total	20	34	54

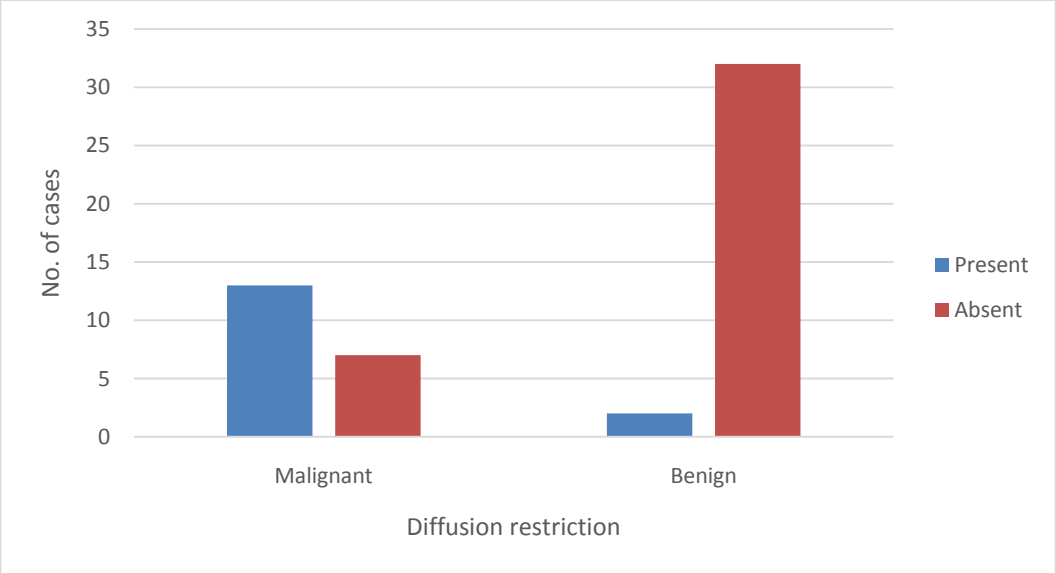


Figure 12: Showing distribution of cases on basis of presence/ absence of diffusion restriction.

Table 16: Diagnostic efficacy of diffusion restriction for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p-value
75%	94.1%	88.2%	86.4%	0.001

2.7) WALL ENHANCEMENT

Contrast enhanced MR was done in 19 out of 54 cases. Out of these, 7 were malignant and 12 were benign stricture.

Wall enhancement was seen in 5 out of 7malignant cases &in 3 out of 12 benign strictures as shown in table 17 & figure 13.

Table 17: Distribution of number of cases into benign & malignant category on basis of wall enhancement (n = 19).

Wall enhancement	Malignant	Benign	Total
Present	5	3	8
Absent	2	9	11
Total	7	12	19

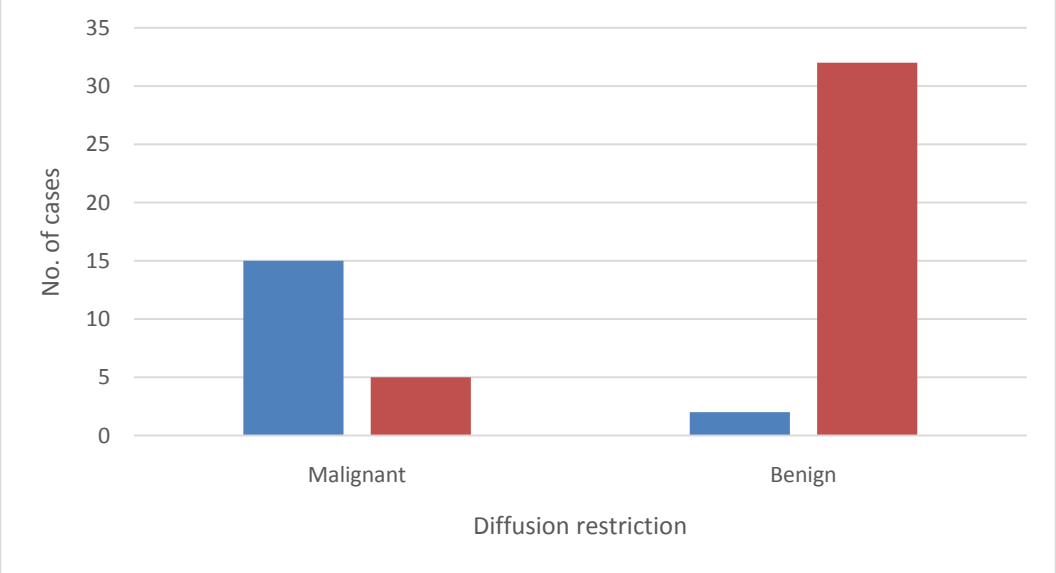


Figure 13: Showing distribution of cases on basis of wall enhancement.

Table 18: Diagnostic efficacy of wall enhancement for characterization of malignant bile duct stricture.

Sensitivity	Specificity	PPV	NPV	p- value
71.4%	75%	62.5%	81.8%	0.048

2.8) NUMBER OF STRICTURE

In our study, single stricture was seen in all 20malignant cases. Out of 34 benign structures,29cases showed single stricture & 5 cases had multiple strictures as shown in table 19 & figure 14.

Number of stricture(s) has no significance (p value – 0.084) in distinguishing between benign & malignant stricture.

Table 19: Distribution of number of cases into benign & malignant category on number of stricture (n = 54).

Number of strictures	Malignant	Benign	Total
Single	20	29	49
Multiple	0	5	5
Total	20	34	54

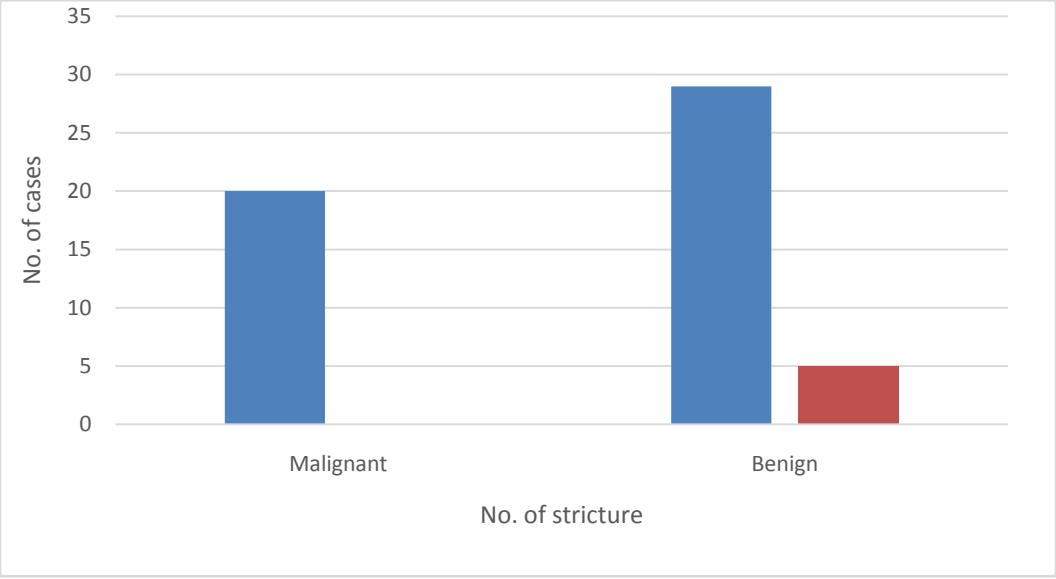


Figure 14: Showing distribution of cases on basis of number of strictures.

2.9) SITE OF STRICTURE

Out of 20 malignant cases, 1 stricture was intrahepatic with involvement of primary confluence, 19 had predominantly extrahepatic stricture with 6 cases involving common hepatic duct, 6 involving suprapancreatic CBD and 8 involving intrapancreatic CBD.

3 benign cases had intrahepatic stricture, 4 benign strictures were present at CHD, 6 involved suprapancreatic CBD and 22 involved intrapancreatic CBD as shown in table 20 & figure 15.

Table 20: Distribution of number of cases into benign & malignant category on basis of stricture (n = 54).

Site of stricture	Malignant	Benign
Intrahepatic	1	3
CHD	5	4
Suprapancreatic CBD	6	6
Intrapancreatic CBD	8	22

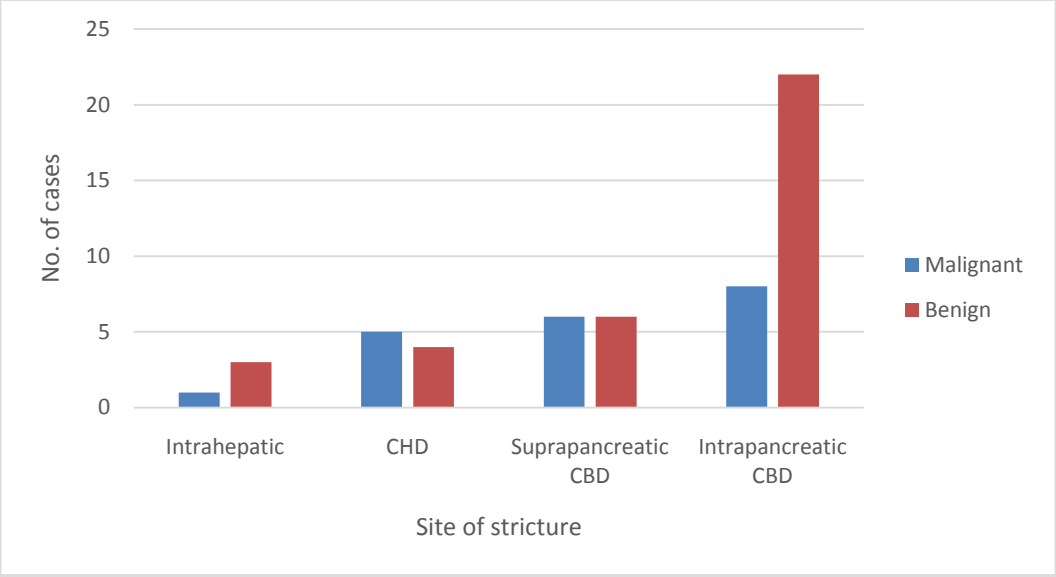


Figure 15: Showing distribution of cases on basis of site of stricture.

No significant correlation was seen (p value 0.068) on basis of site of stricture to differentiate benign from malignant stricture.

2.10) Overall diagnostic accuracy of MRCP for distinguishing malignant and benign stricture

22 cases were diagnosed as malignant stricture on the basis of MRI/MRCP findings. On ERCP/cytology/surgical/histopathology, 19 cases were positive for malignancy with 3 false positive cases.

In 32 cases, the stricture was diagnosed to be benign on the basis of MRI/MRCP findings, which on further clinical, laboratory, endoscopic and pathological workup 31were proven to be benign and 1 was false negativeas shown in Table 21

Table 21: Distribution of number of cases into benign & malignant category on MRCP in correlation with the final diagnosis (ERCP/cytology/surgical /histopathology).

	Final diagnosis		
MRCP diagnosis	**Malignant**	**Benign**	Total
Malignant	19	3	22
Benign	1	31	32
Total	20	34	54

Diagnostic efficacy in terms of sensitivity, specificity, positive predictive value (PPV), & negative predictive value (NPV) for malignant stricture was calculated as shown in Table 22.

Table 22: Overall diagnostic efficacy of MRCP for characterization of malignant bile duct stricture.

Sensitivity	**Specificity**	**PPV**	**NPV**	**Diagnostic accuracy**
95%	91.1%	86.3%	96.8%	92.5%

DISCUSSION

The main diagnostic challenge for a radiologist is differentiation of benign from malignant biliary stricture when a patient presents with clinical & laboratory suspicion of biliary obstruction. Since the treatment and prognosis varies depending upon different causes of stricture, it is important to identify accurately the cause of obstruction. Despite the advancing & evolving imaging modalities, differentiating between the two is still a diagnostic hurdle. The reported accuracy of MRCP in differentiation of benign from malignant cause of obstruction has varied from 30-80 %[9,17,40].

MRCP is an alternative to diagnostic endoscopic retrograde cholangiopancreatography (ERCP) for investigating various etiologies of biliary obstruction. The use of MRCP, a non-invasive procedure, may prevent the use of unnecessary invasive procedures. Indications for the use of MRCP include: unsuccessful or contraindicated ERCP, patient preference for non-invasive imaging, patients considered to be at low risk of having pancreatic or biliary disease; patients where the need for therapeutic ERCP is considered unlikely, and those with a suspected neoplastic cause for pancreatic or biliary obstruction[41].

Sedation is not usually required. MRCP is particularly useful where ERCP is difficult, hazardous, or impossible. It is also an important option for patients with failed ERCPs. ERCP and MRCP have different contraindications allowing them to be used as complementary techniques.

We carried out a prospective study over a duration of one year by using MRCP to study the spectrum of biliary stricture & also to differentiate benign and malignant biliary stricture based on specific morphologic parameters.

In present study, mean age of patients with malignant biliary obstruction was higher than benign obstruction. Mean age of patients with benign stricture was 50.5 ± 14.8 years and of malignant stricture was 59.9±

15.2years. Similar results were seen in study conducted by Saluja et al which had mean age of malignant stricture cases of 54±9 years[16].

Our study showed that, the ratio of benign biliary stricture among men and women was 3:1 & in patients with malignant biliary stricture, the ratio was found to be 2:1. There was slight male preponderance in biliary obstructive diseases in our study. Malignant diseases were more common in males as reported previously by Saluja et al. &Park et al.[16,25].

Out of 20 malignant stricture, GB malignancy was the most common cause n=7(35%) followed by pancreatic head/ periampullary carcinoma n= 6(30%). Other causes were cholangiocarcinoma n=4 (20%) cases, metastatic/ lymph nodal deposits n=3(15%).

Out of 20 malignant strictures, MRI/MRCP detected malignant cases with sensitivity 95%, specificity 91.1% and diagnostic accuracy 92.5 %. Similar results were seen in studies done by Lopera et al & Reinhold et al.[15,42]. Shabanikia et al. in their study showed the sensitivity and specificity of MRCP to detect malignancy were 95.7% and 96.3%, respectively[39]. Saxena et. al also reported overall diagnostic accuracy of MRCP in differentiating benign from malignant biliary strictures in correlation with ERCP, surgical and histopathological outcome was 94.44 %, sensitivity 93.94%, specificity was 95.24%. PPV 96.87 % and NPV 90.91%[43].

The imaging features on MRI/MRCP those favored malignant stricture were wall thickness more than 3 mm (p-value 0.001), asymmetry (p-value 0.001), hyperintense signal of the stricture relative to liver parenchymal signal intensity (0.001), abrupt narrowing (0.002), long segment more than 12 mm involvement (p-value 0.001) , with evidence of diffusion restriction on DW- ADC mapping (p- value 0.001) and hyperenhancement on venous phase images relative to the liver parenchymal enhancement (p- value 0.048).

In current study, the wall thickness of the malignant stricture ranged between 2.1 mm to 5 mm & a cut off 3 mm using ROC curve analysis showed statistically significant difference in distinguishing malignant from

benign stricture with p value of 0.001 i.e., malignant biliary strictures show a thicker ductal wall than benign strictures. Kim et al[29] in their study also set a cut off of 3 mm which also showed statistical difference of thicker walls in malignant stricture with p value of 0.001. Other few studies also demonstrated thicker walls in malignant stricture such as study done by Schulte et al[44] which showed ducts involved with cholangiocarcinoma measured more than 5 mm in thickness, and was one of a distinguishing feature favoring malignancy & Park et al[45] suggested 2.8 mm as a cutoff value for malignant stricture.

Asymmetry of the wall was observed in 18 out of 20 malignant cases and in 2 out of 34 benign cases with p value 0.001 for diagnosing malignant stricture. H.J.Park et al in their study also reported that asymmetric narrowing was seen in 37 out 42 malignant cases with p value of 0.001[46]. Park at el., also in their study concluded that asymmetric narrowing is associated with malignant stricture and is an important feature along with irregular margins in distinguishing extrahepatic bile duct carcinoma from benign biliary stricture[43].

Hyperintense signal of the stricture segment on T2WI was significantly more common in cases of malignant stricture with p value of 0.001 while hypointensity/isointensity was seen more in benign strictures. Worawattanakul et al[47], reported that malignant bile duct strictures showed mild hyperintensity on T2- weighted images, consistent with our findings.

H.J. Park[46] reported a considerable number of benign and malignant strictures of the bile duct showed overlapping imaging features, such as iso- to hyperintensity on T2-weighted images with possible reason benign strictures showing iso- to hyperintensity on T2-weighted images as similar as those of malignant strictures due to active inflammation in few cases of benign stricture.

Abrupt tapering of stricture segment was found in both benign and malignant, however it was significantly more common in malignant biliary

strictures in our study while gradual tapering was observed only in benign biliary strictures. Shabanikia et al. also reported that abrupt tapering was able to predict the malignancy with a sensitivity of 96% and specificity of 74%[39].

However, previously in the study by Katabathina et al, it has been reported that, abrupt narrowing was more commonly observed in benign pathologies due to ultrashort strictures of the CBD[4]. Park et al., stated that abundant fibrosis and desmoplastic reaction without definite mass formation in some bile duct carcinomas may lead to a stricture that involves a long ductal segment and appears gradually tapered and without mass effect rather than abruptly narrowed[25].

Although abrupt narrowing was not a specific criterion for malignancy as it was also present in benign lesions. Abrupt tapering was considered as a malignant MRCP feature in our study which showed p value of 0.002.

Long segment (>12 mm) narrowing was observed more commonly found in malignant stricture and short segment strictures were more commonly benign in nature. Malignant strictures are usually long as they have an infiltrative growth pattern, which spreads intramurally beneath the epithelial lining[16]. Yu et al., in their study reported that malignant strictures were significantly thicker and longer than the benign strictures and upstream CBD dilatation was larger in the infiltrative cholangiocarcinoma cases than in the benign cases[35]. Park et al., in their study also reported that MR Cholangiopancreatography is comparable to ERCP in differentiating extrahepatic bile duct cholangiocarcinoma from a benign stricture and showed that a lengthy narrowed segment with irregular margins is more suggestive of malignancy[25].

Among 54 cases, it was observed that diffusion restriction was significantly more associated with malignant stricture with p value of 0.000.

H.J.Park et al in their study demonstrated most malignant strictures demonstrated lower signal intensity (diffusion restriction) on the ADC map

than normal bile duct compared to benign strictures with diagnostic accuracy ranging from 91.3% to 94.2%[46], since DWI provides information which reflects the integrity of cellular membrane and tissue cellularity[18,48,49], the diffusion restriction seen for malignant strictures can be attributed to rich tumoral cellularity.

Conversely, diffusion restriction was not seen in benign strictures presumably due to fibrosis, infiltration of inflammatory cells and an increase in extracellular fluid without tumoral cell proliferation, which leads to prolongation of the T2-relaxation time without diffusion restriction.

It has been suggested by H.J.Park et al that adding DWI to conventional MRI & MRCP can help distinguish benign from malignant bile duct strictures with increased diagnostic accuracy & help in avoiding unnecessary biopsy or surgery in benign stricture cases[46].

Post contrast enhancement characteristics of hyperenhancement of the wall relative to liver parenchyma was assessed in 19 patients, which showed sensitivity of 71.4%, specificity of 75% with p value of 0.048 for diagnosing malignant stricture. Five out of seven malignant cases showed hyperenhancement while in benign cases only 3 out 12 strictures showed hyperenhancement.

Kim et al in their study showed malignant biliary strictures were better depicted on postcontrast T1W images than on precontrast images with hyperenhancement of a stricture segment of bile duct relative to liver parenchyma in almost all of the malignant strictures (20/21; 95.2%) & in benign strictures, only five of our 23 cases (21.7%) showed hyperenhancement relative to the liver parenchyma[29].

Worawattanakul et al[47], also showed that bile duct malignancies were best visualized on gadolinium (Gd)- enhanced fat-suppressed T1W images acquired one to five minutes following administration where they reported that the degree of enhancement of malignant tumors ranged from minimal to intense on immediate Gd-enhanced images, with gradual homogeneous enhancement between one- & five-minutes following

contrast administration. Some benign strictures with inflammatory disease showed enhancement, but the degree was similar to that of liver parenchyma, whereas malignant strictures showed stronger enhancement than liver parenchyma in almost all cases.

We had one case diagnosed as malignant mid CBD stricture with obstructive biliopathy and periportal lymphadenopathy with MRCP features of long segment, abrupt, asymmetrical, T2 hyperintense narrowing with hyperenhancement on post gadolinium T1W images which turned out to be benign inflammatory stricture on cytology and ERCP findings. The possible explanation for this could be that due to active inflammation, there was abrupt narrowing with T2 hyperintensity and wall enhancement.

Among 54 cases, 34 were benign biliary strictures which were categorized into four groups according to the cause of obstruction as observed on MRI/MRCP and correlated with ERCP, cytology, histopathology, and operative findings. MRI/MRCP had sensitivity 91.1%, specificity 95%, and accuracy 92.5% for diagnosis of benign strictures. Our results are comparable with previous studies by Hintze et al., in which sensitivity of MRCP was 87% and specificity 87% for the diagnosis of benign stricture[(19)]. Lee et al., in their study found that sensitivity of MRCP in diagnosis of benign lesions was 81%, specificity 92% and diagnostic accuracy 87%[(20)]. Meena Suthar et al in their study reported that diagnostic accuracy of MRCP in differentiating benign from malignant biliary obstructive diseases in correlation with surgical, ERCP and histopathological outcome was 93.3%, sensitivity 85.7%, specificity 96.3%[(37)].

Inflammatory stricture including those due to chronic calcific pancreatitis, paraduodenal / groove pancreatitis& primary sclerosing cholangitis was the most common pathology seen from our cohort which comprised 22 (64.8%) patients. This was probably due to the type of sample population as more cases of chronic pancreatitis are referred to our hospital.

However, previous studies have reported post-cholecystectomy stricture as the most common cause of benign stricture as reported by Meena Suthar et. al[37]and Shabanikia et al[39].

The most common site of stricture due to pancreatitis was observed to be distal/ intrapancreatic CBD which is in concordance with the findings by Katabathina et al[4]. The pathogenesis is likely to be due to fibrosis of the periductal peripancreatic parenchyma.

In our study, one stricture was diagnosed as periampullary carcinoma in view of dilatation of IHBR with positive double duct sign and short segment, abrupt narrowing. Stricture wall showed hyperintense signal with post contrast enhancement. On ERCP, small CBD stone with ampullary stenosis was noted. Histopathology turned out to be negative for malignancy & hence a false positive diagnosis for malignant stricture was made based on MRI/MRCP.

This is in accordance with the findings reported by Shi EC et al. in their study that choledocholithiasis is associated with chronic inflammation and scarring. The stricture associated with chronic choledocholithiasisis usually short-segment and shows minimal wall thickening and post contrast enhancement of the narrowed segment. Stricture can form both above and below calculi in the biliary tree& patients with chronic cho-ledocholithiasis and strictures are prone to cholestasis, cholangitis[50].

In a case of primary sclerosing cholangitis who was a known case of ulcerative colitis with biliary cirrhosis, showed multiple short segment intrahepatic strictures, biliary ductal irregularities and segmental extrahepatic bile duct wall thickening with enhancement on post contrast images on MRCP. Similar findings were described by Katabathina et al., described similar findings in cases of primary sclerosing cholangitis on MRCP which included multiple intrahepatic and extrahepatic segmental biliary stricture with alternate segments ofmildly dilated ducts & peripheral pruning of intrahepatic bile duct. CEMR show multifocal wall thickening and enhancement of bile duct[4].

In our study population, there were 5 cases of post cholecystectomy stricture, out of which 4 cases were Bismuth type 1 & one case was Type 2. This is in accordance with classification system proposed by Bismuth H. for location of post operative biliary stricture which is important for the surgeon to plan repair & anastomosis[5].

Infective benign biliary stricture included 4 cases of recurrent pyogenic cholangitis which had multiple intrahepatic strictures as well as extrahepatic strictures with some of them showing features of hepatolithiasis. All these strictures had wall thickness <3 mm, symmetrical, short segment<12mm with hypointense walls and no diffusion restriction on DW-ADC images.

All cases of recurrent pyogenic cholangitis had abrupt narrowing. Our findings are similar to the observations reported by Kim et al, as in their study, benign strictures due to recurrent pyogenic cholangitis were located distal to biliary stones which showed abrupt narrowing (16/23; 69.6%)[29]. Histologically, there were inflammatory and fibrotic changes in the bile duct walls, periportal spaces, and hepatic parenchyma that led to stricture formation. Chronic physical irritation by biliary stones, bile stasis, and concomitant infection led to severe periductal fibrosis and hence can be a cause of abrupt narrowing[51].

Multifocal segmental intrahepatic and extrahepatic biliary strictures with associated periportal lymphadenopathy were seen in a case of HIV cholangiopathy. This is in accordance to Bilgin M et al, who reported that MRCP reveals findings similar to ERCP of multiple intrahepatic strictures, segmental extrahepatic biliary strictures, and enhancement of the bile duct wall. Among these, segmental extrahepatic biliary strictures are considered characteristic of AIDS cholangiopathy[52].

Autoimmune (IgG4 related) disease biliary stricture was seen in n = 2(5.8%) in which one case had distal CBD stricture with short segment, symmetric, T2 hypointense walls. This is in accordance with

findingsreported by Kamisawa et al. that focal distal CBD stricture is more common in type 1 autoimmune pancreatitis[53].

A benign stricture with perihilar soft tissue showing diffusion restriction was labelled as malignant stricture based on imaging parameters and mildly elevated CA 19-9 levels. Cytology turned out to be negative for malignant cells, serum IgG4 levels were obtained which showed elevated values. It has been reported by Katabathina et al.[4], that IgG4-related sclerosing cholangitis can mimic other disease entities such as cholangiocarcinoma, pancreatic adenocarcinoma & few benign entities.

Overall, in our study, out of 54 cases, 34 were benign causes of biliary stricture whereas 20 cases had malignant stricture. Among 54 patients, 50 were correctly diagnosed and properly evaluated by MRCP. 31 cases of benign stricture were correctly diagnosed on MRI/MRCP while 1 case diagnosed as benign turned out to be malignant. Three cases labelled as malignant strictures on MRI/MRCP, turned out to benign on correlation with final diagnosis.

The sensitivity, specificity and diagnostic accuracy of MRCP for differentiation of malignant from benign biliary stricture was 95%, 91.1%, and 92.5% respectively.

In previous studies, sensitivity of MRCP for detection of cause of benign and malignant obstruction ranged from 92-100%. Saluja et al., found sensitivity, specificity and diagnostic accuracy of MRCP for malignant biliary obstructive diseases in their study to be 87.5%, 85.3% and 82.7% respectively similar to our study[16].

To conclude MRCP should be used as a non-invasive imaging modality for diagnosis of biliary stricture and hence it is an important role of the radiologist in differentiating benign versus malignant cause of biliary stricture. The importance of having the proper knowledge about the nature of stricture helps guide adequate management both for the gastroenterologist and the surgeon and help avoid unnecessary complications.

The major limiting factor in our study was short sample size of the cohort and hence future studies should be done on a larger sample for adequate extrapolation of the results. Another limiting factor was that the post contrast assessment could be done only in 19 patients and thereby further reducing the sample size. Contrast administration should be encouraged while performing MRI and MRCP studies as it improves the resolution and helps in better characterization of the cause for biliary stricture.

SUMMARY AND CONCLUSION

- The mean age group for benign stricture was 50.5 ± 14.8 years and for malignant stricture was 59.9± 15.2 years.
- The ratio among men and women of benign biliary stricture was 3:1 and in malignant biliary stricture was 2:1.
- Benign spectrum of biliary stricture included inflammatory stricture including chronic pancreatitis& PSC as the most common cause of benign stricture, followed by post-cholecystectomy strictures. Infective causes included recurrent pyogenic cholangitis & HIV related cholangiopathy. Other cause was autoimmune (IgG4 related) disease.
- Malignant spectrum of biliary stricture included GB malignancy as the most common cause, followed by pancreatic head/ periampullary carcinoma. Other causes were cholangiocarcinoma, metastatic/ lymph nodal deposits.
- Symmetric, hypo/isointense, short segment narrowing showing no diffusion restriction on DW-ADC mapping & no hyperenhancement on post gadolinium images were significantly more commonly found in benign strictures.
- Asymmetric, T2 hyperintense, long segment narrowing with evidence of diffusion restriction on DW-ADC mapping & venous phase hyperenhancement were significantly more commonly found in malignant stricture.
- Abrupt narrowing was significantly more associated with malignant strictures & gradual narrowing was only associated with benign strictures.
- The sensitivity, specificity and diagnostic accuracy of MRCP for differentiation of malignant from benign biliary stricture was 95%, 91.1%, and 92.5% respectively.

CONCLUSION

We conclude that MRCP has high diagnostic accuracy and is equivalent to ERCP in diagnosing biliary stricture(s). MRCP is the method of choice for the diagnostic imaging of biliary pathologies and ERCP is reserved for therapeutic intervention in this setting as the commoner pathologies (stones, strictures and malignancies in upper biliary tract) can be easily identified with high specificity with MRCP. The results obtained in the study were comparable to pioneer studies conducted worldwide. All cases of obstructive jaundice should undergo MRCP so that ERCP can be used only for therapeutic purpose.

MRCP is first hand tool for diagnosing biliary abnormalities. ERCP is an invasive procedure that requires an intravenously administered sedative and ionizing radiation, and it is relatively time consuming. In addition, ERCP is expensive, may be technically unsuccessful in about 4% of patients, can result in incomplete evaluation in patients with high-grade strictures due to non-visualization of upstream ducts, and is associated with a complication rate. Unenhanced and contrast-enhanced MR imaging with MR cholangiopancreatography is extremely helpful in the evaluation of the narrowed bile duct segment and may suggest findings that are specific for a malignant cause.

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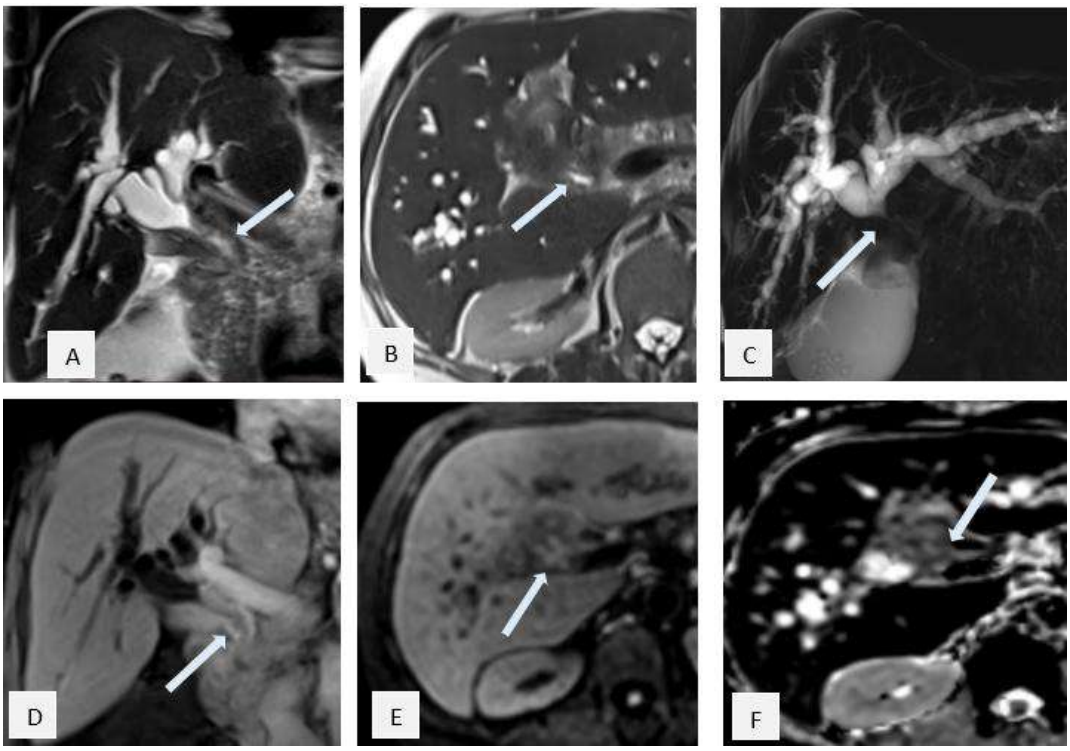
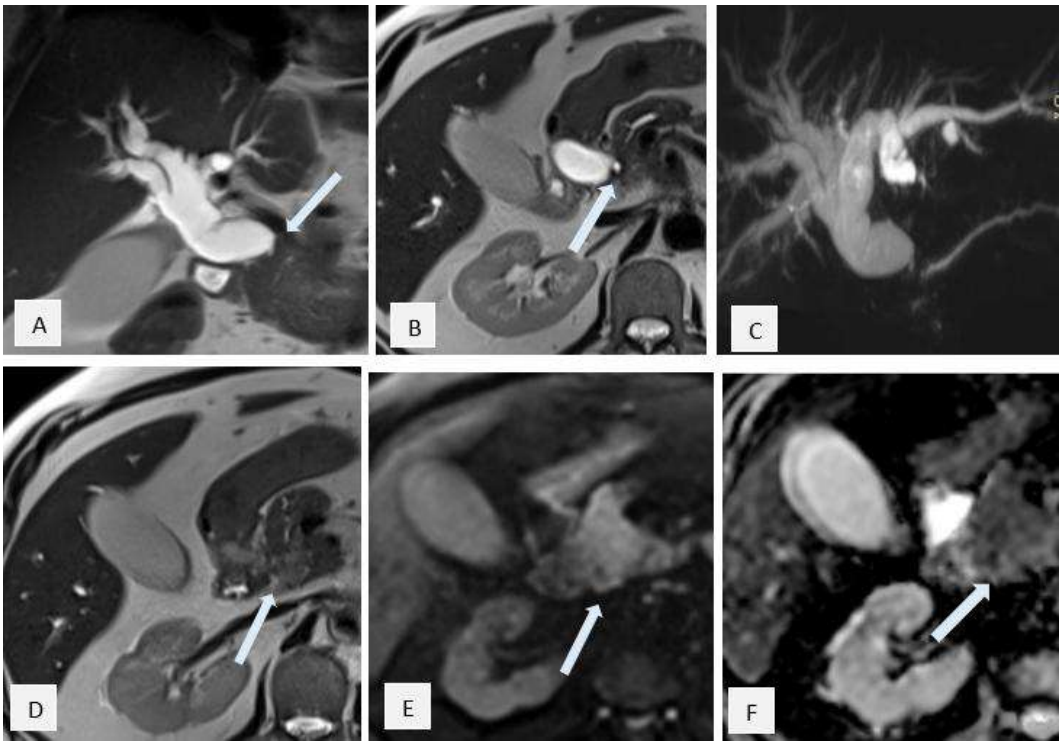
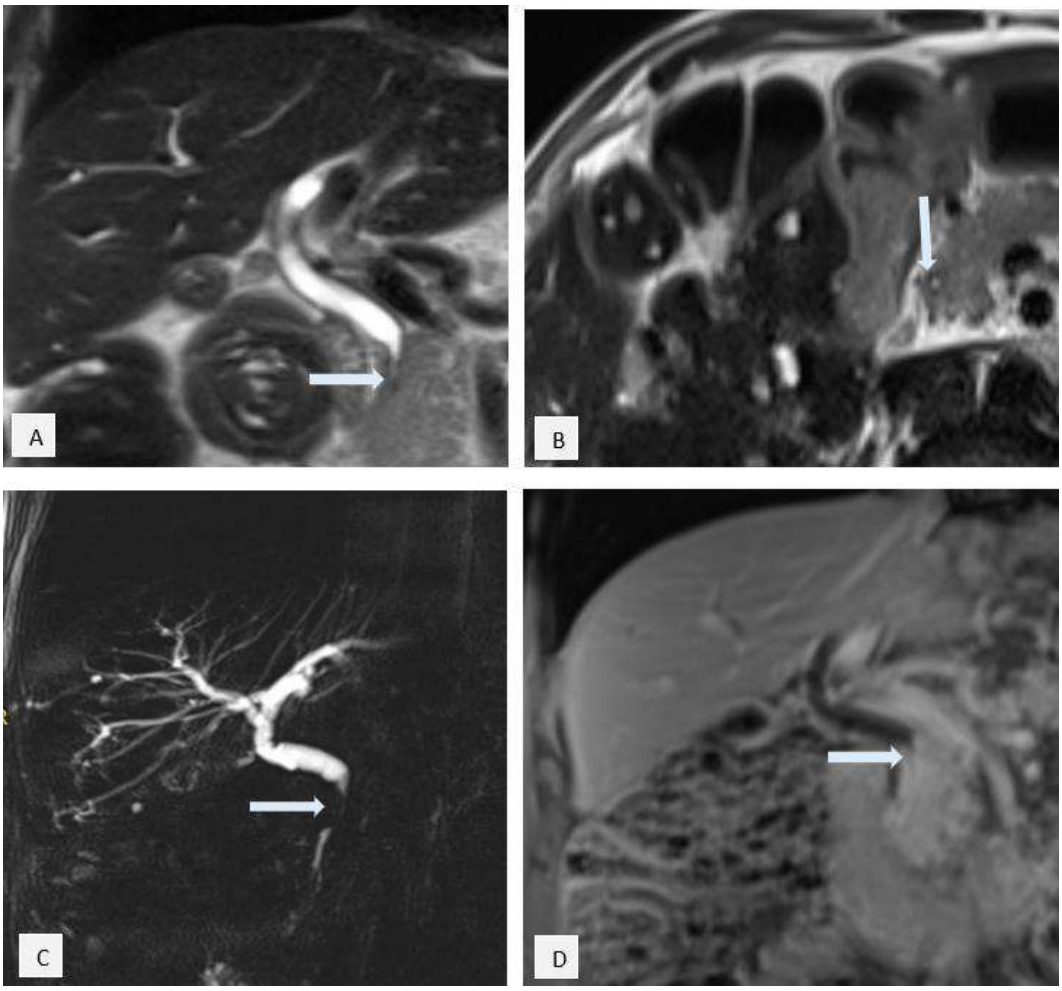


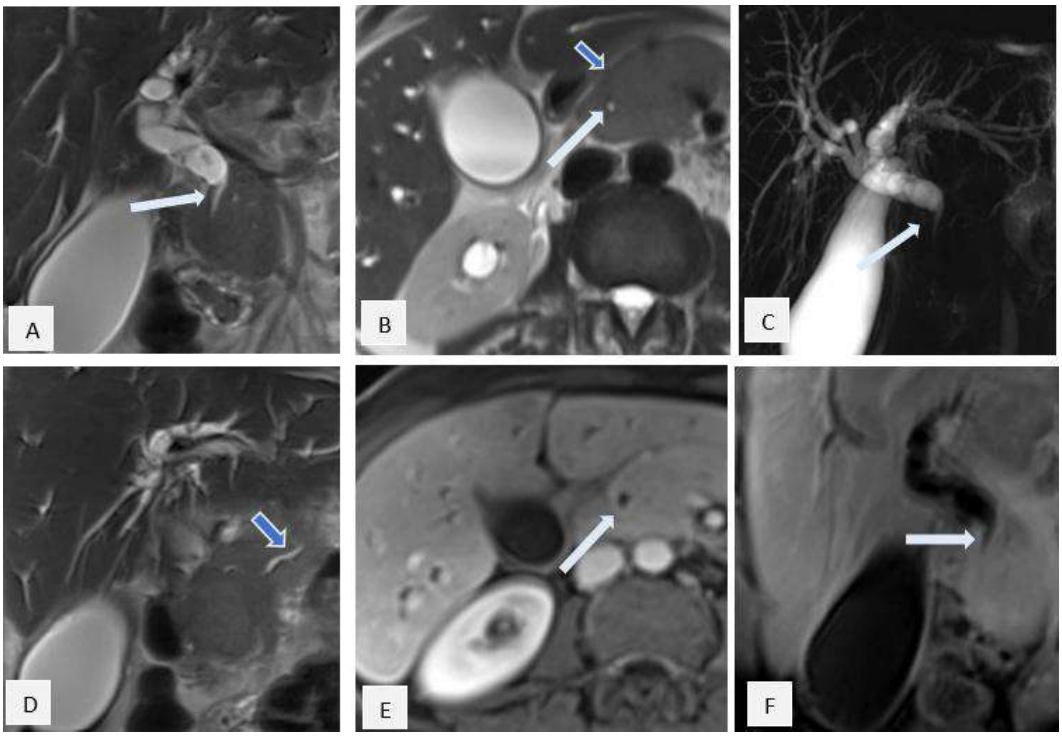
Picture 11: A 57-year-old male patient with obstructive jaundice and weight loss. (A) & (B) coronal and axial T2WI which show irregular relatively hyperintense, asymmetrical, long segment wall thickening of the supra pancreatic CBD. (C) The MIP 3D MRCP image shows abrupt narrowing of the supra pancreatic CBD distal to the hepatic hilum with significant upstream bilobar IHBRD. (D) CE-T1WFS image shows hyperenhancement of the stricture segment. (E) & (F) show diffusion restriction in the thickened wall on DW - ADC sequence. Overall findings favored the diagnosis of malignant stricture of the CBD and was proven histologically to be cholangiocarcinoma.



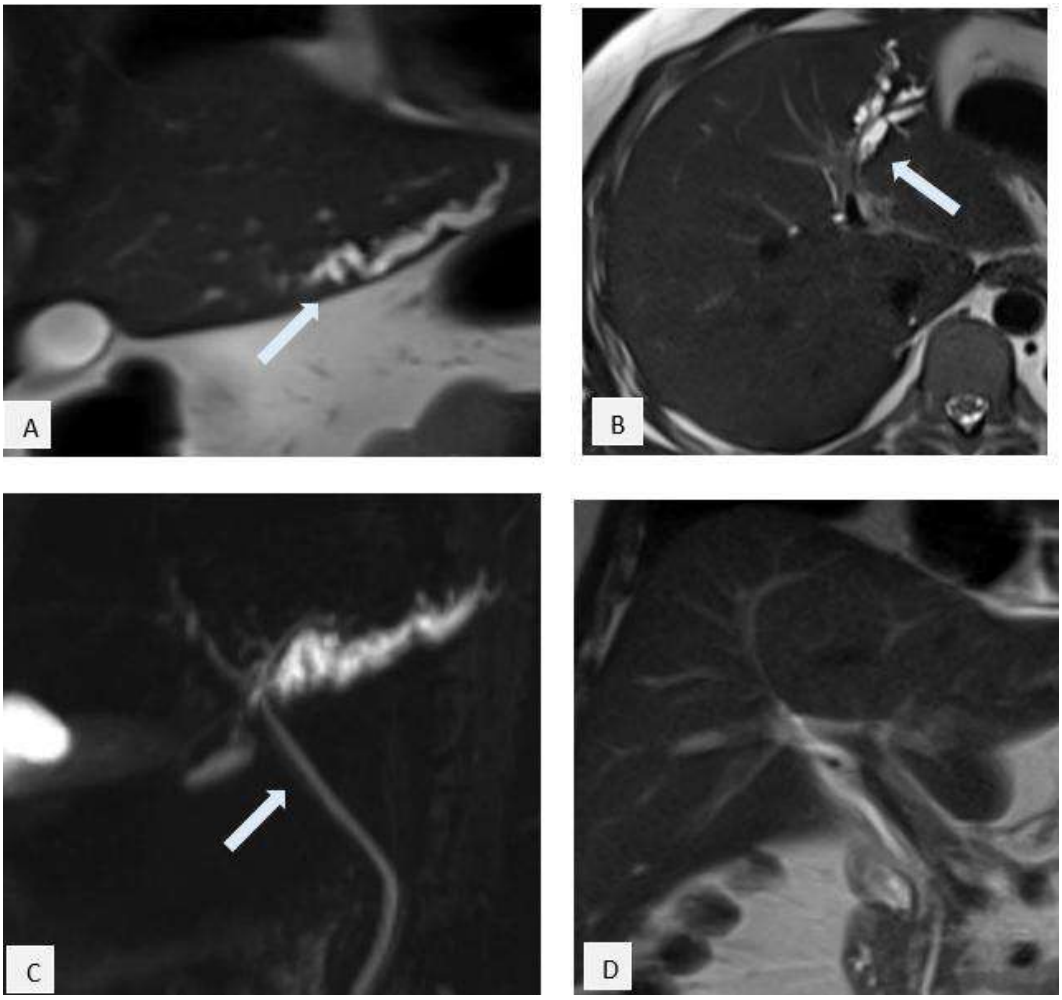
Picture 12: A 53-year male presented with pain in the epigastric region radiating to the back with obstructive jaundice (A) & (B) coronal and axial T2WI shows abrupt narrowing of the intrapancreatic CBD with significant upstream bilobar IHBRD& dilatation of CBD. (C) MIP 3D MRCP image shows the trifurcation pattern of the biliary tree with the abrupt termination of intrapancreatic CBD. (D) shows T2 intermediate signal intensity lesion involving the head and uncinate process of the pancreas. (E) & (F) mass lesion showing diffusion restriction on DW-ADC images. Histopathology confirmed – carcinoma head of the pancreas.



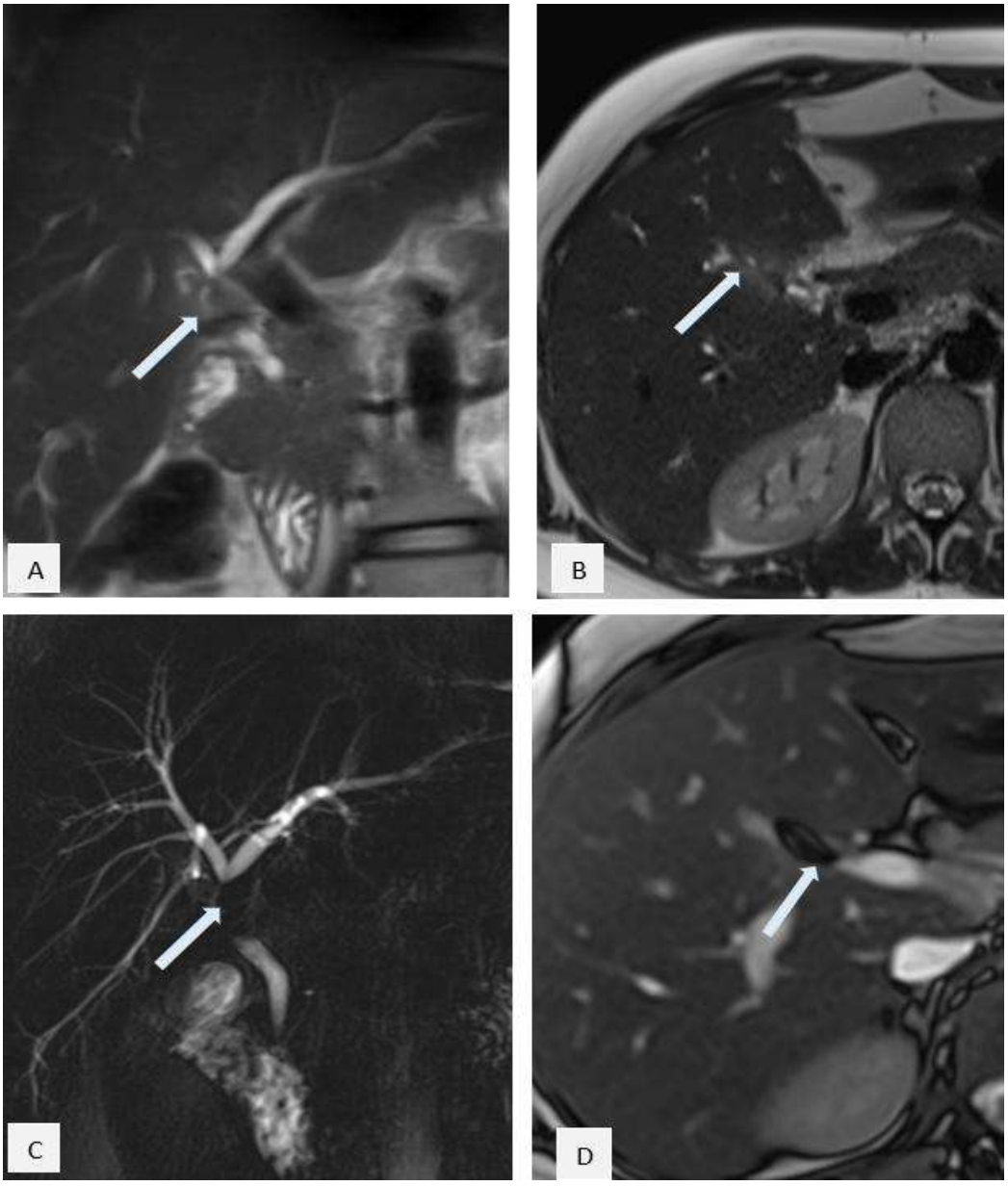
Picture 13: A 47-year female with vague abdominal pain & deranged LFTs. (A) & (B) coronal and axial images show gradual, smooth intrapancreatic CBD narrowing. (C) shows MIP 3D MRCP image with smooth stricture with upstream bilobar IHBRD. (D) CE-T1FScoronal image shows no hyperenhancement of the walls of the stricture segment. Overall findings were suggestive of benign inflammatory stricture which was confirmed on ERCP and cytology negative for malignant cells.



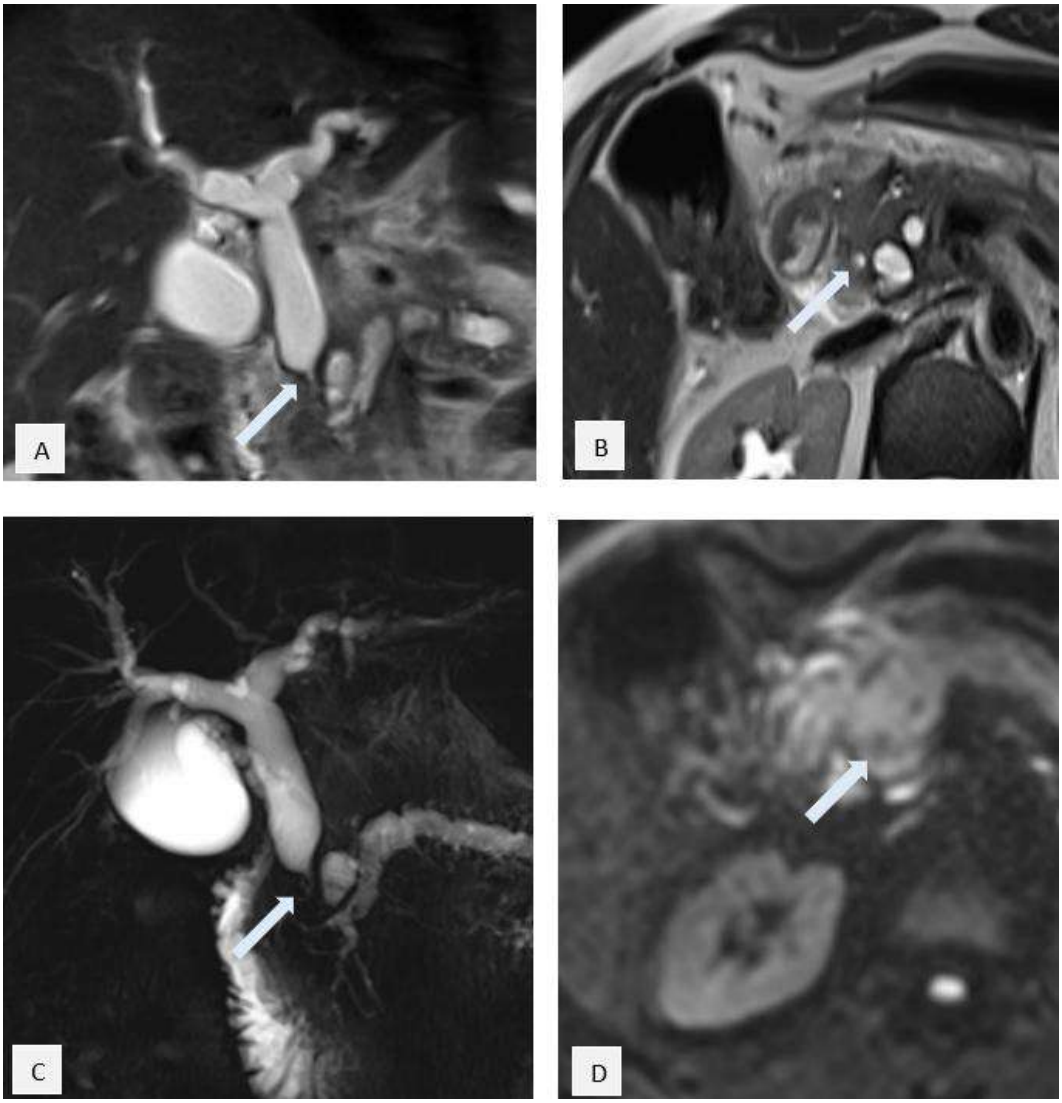
Picture 14: A 56-year female with epigastric abdominal pain & elevated IgG4 levels. (A) & (B) coronal and axial images show relatively gradual, smooth narrowing of the intrapancreatic CBD. The Head & proximal body of the pancreas appear bulky with T2 hypointense halo (dark blue arrow) pointing towards autoimmune pancreatitis. (C) shows MIP 3D MRCP image with smooth stricture with upstream bilobar IHBRD. (D) coronal T2WI shows irregular dilatation of the MPD with marked luminal narrowing in the head region. (E) & (F) CE-T1FS axial and coronal image shows no hyperenhancement of the walls of the stricture segment withhomogenous enhancement of the pancreas.



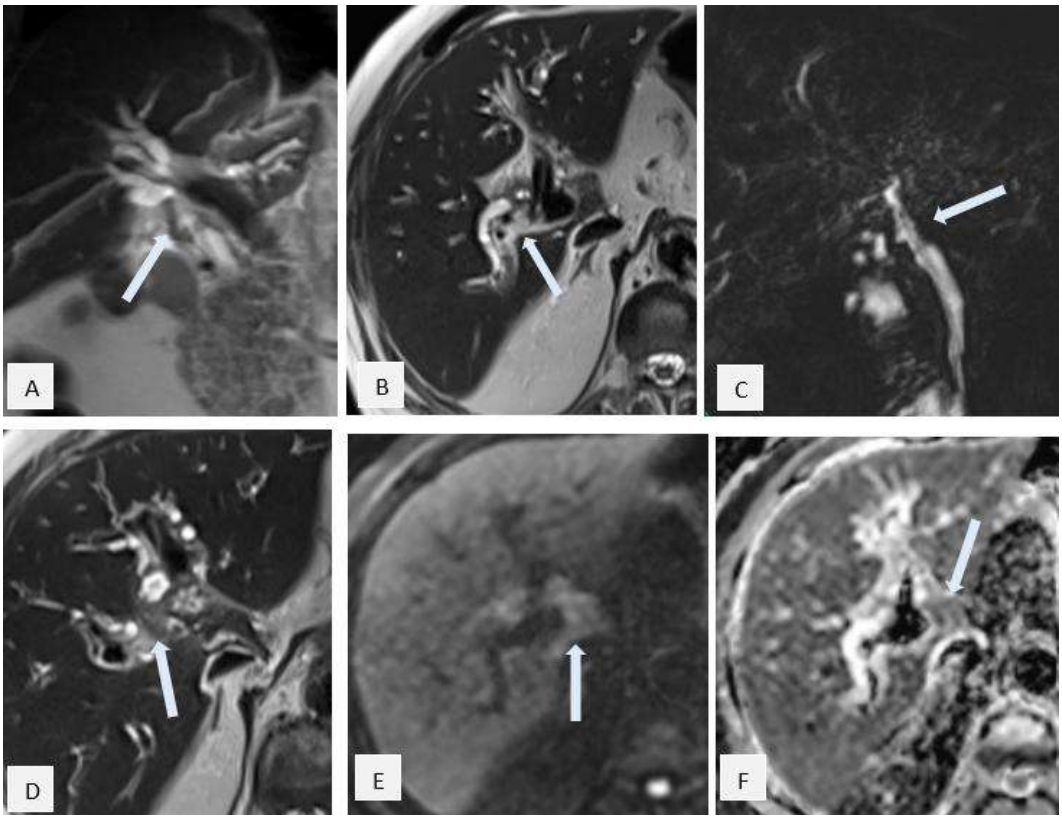
Picture 15: A 35 year female with recurrent episodes of pain right abdomen, fever, and jaundice. (A) & (B) coronal and axial images show relative atrophy of the left lobe of the liver with crowding of the biliary radicals which are irregularly dilated.(C) MIP 3D MRCP image shows irregularity of the biliary radicals in the left lobe with normal appearing extrahepatic CBD and right-sided biliary radicals. (D) Coronal T2WI shows normal-appearing rest of the liver parenchyma.The findings were confirmed on ERCP and diagnosed with recurrent pyogenic cholangitis.



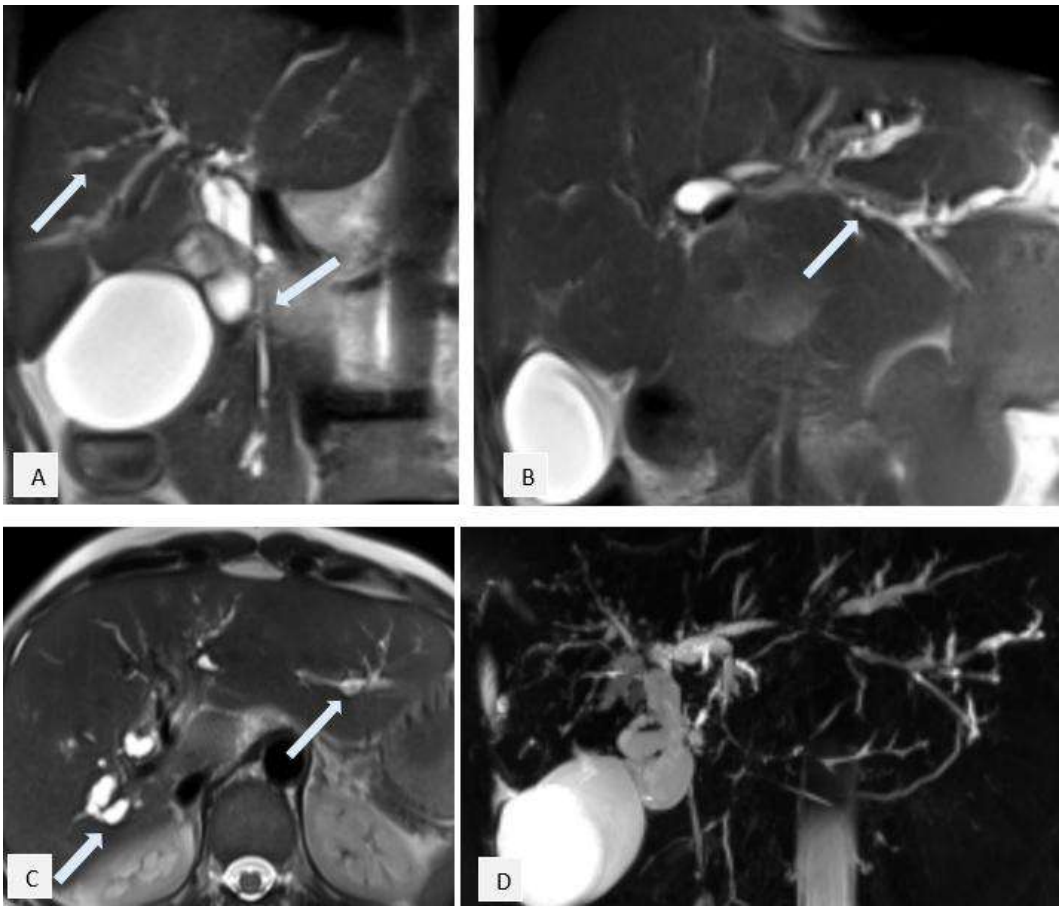
Picture 16: A 23-year male with a past history of cholecystectomy, presented with pain in the right hypochondrium. (A) & (B) coronal and axial T2WI shows abrupt cut off of the CBD just after the formation of primary confluence at the hepatic hilum. (C) MIP 3D MRCP image shows a segment of near complete non-visualization of the part of supra pancreatic CBD with normal intrapancreatic CBD. (D) T2W Trufi image shows cholecystectomy clips in GB fossa.



Picture 17: A 41-year male, alcoholic, with a known case of chronic pancreatitis presented with pain abdomen. (A) & (B) coronal and axial T2WI shows abrupt narrowing of intrapancreatic CBD with markedly dilated and tortuous MPD and side branch dilatation. (C) MIP 3D MRCP image demonstrates short segment narrowing of the intrapancreatic CBD & stricture of MPD in the region of the head. (D) DW image shows no hyperintensity to suggest diffusion restriction.



Picture 18: A 60 year male with weight loss and obstructive jaundice referred for MRCP. (A) & (B) coronal and axial T2WI shows irregular narrowing of the extrahepatic CBD with T2 intermediate signal intensity periductal soft tissue thickening. (C) MIP 3D MRCP image shows the irregular luminal contour of extrahepatic CBD with normal appearing distal CBD. (D) Axial T2WI shows soft tissue thickening extending along the right and left hepatic duct causing its luminal attenuation. (E) & (F) show diffusion restriction on DW-ADC images. Imaging appearance suggests malignant stricture. Further workup revealed elevated IgG4 levels and brushings from CBD were negative for malignant cells.



Picture 19: A 51-year female who was a known case of ulcerative colitis presented with melena and pain epigastric region. Blood investigations revealed deranged LFTs with elevated alkaline phosphatase levels. (A) Coronal T2WI shows irregularly dilated peripheral intrahepatic biliary radicals in the right lobe with a dominant stricture of the supra pancreatic CBD. (B) Coronal T2WI shows irregularly dilated biliary radicals in the left lobe of the liver. (C) Axial T2WI shows relative hypertrophy of lateral segments of the left lobe with irregularly dilated bilobar central and peripheral biliary radicals. (D) MIP 3D MRCP image demonstrates multiple intrahepatic and extrahepatic bile duct strictures in a patient with primary sclerosing cholangitis.

KEY TO MASTERCHART

GB MASS

0- Present

1- Absent

GB WALL THICKNESS

0- Normal(Symmetrical)

1- Asymmetrical

IHBR dilatation

0- Unilobar

1- Bilobar

Site of stricture

0- Intrahepatic

1- Primary confluence

2- CHD

3- Suprapancreatic

4- Intrapancreatic

Number of stricture

0- Single

1- Multiple

Symmetry

0- Asymmetrical

1- Symmetrical

Signal intensity

0- Hyperintense

1- Hypointense

2- Isointense

Diffusion restriction

1-Yes

2-No

Luminal contents

0- Calculi

1- Sludge

2- None

Focal lesion head of pancreas

0- Yes

1- No

Wall enhancement

0- Yes

1- No

Narrowing

0- Abrupt

1- Gradual

S. No	MRD	Name	Age	SBilT (mg/dl)	SBilD (mg/dl)	AST	ALT	ALP	Amylase	Lipase	Ca19-9	Lesion hepatic segment	HILAR INVOLVEMENT	GB Masslesion	Postop	GB Wallthickness	RHD calibre	LHD calibre	CHD calibre	CBD calibre	IHBRdilatation	Site of stricture	Number of stricture	Symmetry	Wall thickness	Wall enhancement	Narrowing	Signalintensity	Length stricture	Diffusion restriction stricture	Luminal contents stricture
1	935008	V.B	60 YEAR	26	20	188	117	972	-	-	-	5	Yes	1	No	1	12.7	11.4	-	-	1	2	0	1	3	0	0	0	18	1	2
2	901497	V.K	62 YEAR	6.3	5.9	198	179	560	-	-	-	PERIPORTAL	Yes	1	No	0	5.5	7.5	8.9	-	1	3	0	0	3.2	-	0	1	17	2	2
3	959429	A.K	30 YEAR	0.6	0.1	49	88	224	-	-	-	NA	NO	1	No	0	-	-	-	6.6	1	0	1	1	0.7	-	0	1	1	2	0
4	964449	M.K	56 YEAR	0.8	0.6	56	82	500	-	-	-	NA	NO	1	No	0	3	4.5	-	12	-	4	1	1	0.6	1	1	2	20	2	2
5	970416	S.C.	69 YEAR	4.9	4.7	142	257	444	56	76	1883	NA	NO	NA	YES	NA	13	13	14	-	1	3	0	0	3.4	-	0	0	11	1	2
6	978894	K.R.	80 YEAR	0.6	0.1	33	19	145	24	17	31.1	NA	NO	1	No	1	4.5	5	8	12	1	4	0	1	2.4	-	1	2	1.7	2	2
7	972228	S.S	66 YEAR	6.5	6.4	57	142	306	-	-	550	4	No	0	No	1	6.7	8	-	-	1	2	0	1	2.9	-	0	0	19	2	2
8	988691	N.B	62 YEAR	0.9	0.8	69	56	322	-	-	12	NA	NO	-	Yes	NA	7.5	10	13	15	1	4	0	1	0.2	-	1	2	3	2	0
9	964504	BA	19 YEAR	0.6	0.5	112	78	299	-	-	-	NA	NO	NA	Yes	NA	3.3	3.5	4.8	-	1	3	0	1	0.5	-	0	1	10	2	2
10	985794	G.D	80 YEAR	22.4	19.1	75	48	308	-	-	1782	NA	Yes	0	No	1	12	11.8	-	-	1	3	0	0	4.5	-	0	0	25	1	2
11	995420	BI	43 YEAR	0.4	0.3	55	32	470	762	1354	4380	NA	NO	1	Yes	0	9.8	11	11.3	-	1	4	0	1	1.2	1	0	0	17	2	2
12	995044	AM	30 YEAR	0.9	0.4	260	308	1012	-	-	-	NA	NO	NA	Yes	-	4.1	5.5	-	-	1	3	0	1	0.8	-	0	1	12	2	2
13	965874	G.K	58 YEAR	18	16	66	69	511	-	-	71	NA	NO	1	NO	0	8.2	9.4	15	17	1	3	0	0	3.9	1	0	1	8	2	2
14	992256	K.C	60 YEAR	0.9	0.8	123	108	188	-	-	4.1	NA	NO	1	No	0	5.4	5.9	11.2	8	1	4	0	1	1.8	-	0	1	9	2	2
15	85939	S.K	62 YEAR	0.5	0.22	18	17	153	-	-	-	NA	-	1	No	0	7	7.5	7.6	7.8	1	4	0	1	0.9	-	1	1	9	2	2
16	1026544	Y.W	45 YEAR	1.6	0.9	117	94	400	-	-	98	-	YES	0	No	1	5.5	6.8	8.1	-	1	3	0	0	3.6	0	0	1	1.7	2	2
17	966581	B.M	71 YEAR	0.8	0.6	36	35	225	-	-	165	-	NO	1	No	0	4.5	5	8.6	12	1	4	0	1	2.2	0	1	1	20	2	2
18	1037025	P.K	60 YEAR	8.6	5.5	72	56	199	46	-	-	ALL SEGMENTS	No	0	No	1	7.8	8	8.5	8.7	1	4	0	0	3	0	0	0	13	1	2
19	1060215	P.S	55 YEAR	8.8	8.4	86	87	285	-	-	10.4	-	NO	1	No	0	14	15.8	16	14	1	4	0	0	2.5	-	0	0	23	2	2
20	1072308	S.K	53 YEAR	4.4	3.7	115	180	534	54	32	-	-	NO	1	Yes	-	3.4	4.4	8.3	8.7	1	4	0	1	0.8	-	1	1	4	2	0
21	984859	A.S	65 YEAR	1.4	1.3	78	115	1650	-	-	168	HILAR MASS	Yes	1	No	0	9.8	8.5	-	-	1	2	0	0	2.1	-	0	0	16	2	2
22	1056497	S.G	53 YEAR	0.5	0.3	16	10	552	-	-	-	-	NO	1	Yes	0	10	10.5	11	11.2	1	4	0	1	2.6	0	0	-	20	2	0
23	1086567	R.K	75 YEAR	-	-	-	-	-	-	-	-	-	NO	1	No	0	4.1	3.9	7	9	1	4	0	1	1	-	0	2	7	2	2
24	395718	H.P	53 YEAR	0.9	0.8	69	78	297	-	-	5.1	-	NO	1	No	0	8.8	9.8	10.2	10.4	1	4	0	1	2.9	-	0	0	13	2	2
25	954689	R.P	59 YEAR	0.5	0.09	41	28	197	-	-	-	-	NO	1	No	0	3.4	4.2	3.9	-	-	0,1,2	1	1	1.3	-	1	1	6	2	2
26	525558	G.K	37 YEAR	0.8	0.2	82	92	132	-	-	-	-	NO	1	No	0	2	5	4.5	4.3	0	0	0	1	0.9	1	0	2	9	2	2
27	969237	S.K	23 YEAR	1.1	0.6	36	30	140	-	-	-	-	NO	1	No	0	12	13	11	7	1	2	1	1	3	0	1	1	12	2	2
28	1155660	S.K.S	60 YEAR	1.1	0.6	36	30	104	-	-	-	-	Yes	0	No	1	8	8.2	3	-	1	2	0	0	3	1	0	1	12	2	2
29	1163861	K.B	58 YEAR	1.9	1.08	83	154	1042	-	-	-	-	NO	NA	Yes	-	7	7.2	11	3	1	3	0	0-	0.8	-	0	2	16	2	2
30	1130519	K.S	43 YEAR	1.05	0.89	89	59	356	-	-	-	-	NO	1	No	0	7	9	11.7	0	1	4	0	1	1.2	0	0	1	10	2	2
31	1176296	A.S	24 YEAR	1.05	0.9	56	34	240	152	223	-	-	NO	1	No	0	9	8.6	10.2	7	1	4	0	1	1.3	-	1	1	10.1	2	2
32	183774	P.P.M	56 YEAR	2.1	1.78	86	98	356	-	-	-	-	NO	-	Yes	-	6.8	7	-	4.5	1	2	0	1	0.8	-	0	1	7	2	0
33	1177138	P.S	51 YEAR	7	6	81	39	786	78	96	-	-	NO	1	No	0	10	9	13	15.5	1	4	0	1	1.2	0	0	1	11	2	2

S. No	MRD	Focal lesion pancreatic head	Imaging diagnosis	Endoscopic findings	Cytology findings	Operative findings	Histopathology	FINAL IMAGING DIAGNOSIS	Final correlation
1	935008	1	GB MALIGNANCY WITH MALIGNANT STRICTURE OF CHD , PRIMARY CONFLUENCE & SECONDARY CONFLUENCE	-	-	-	ADENOCARCINOMA GB	MALIGNANT	MALIGNANT
2	901497	1	METASTATIS DEPOSIT IN PERIPORTAL LOCATION WITH STRICTURE OF SUPRAPANCREATIC CBD	MID CBD STRICTURE	SUSPICIOUS FOR M-CELLS	-	-	MALIGNANT	MALIGNANT
3	959429	1	MULTIFOCAL INTRAHEPATIC STRICTURES & OF PRIMARY CONFLUENCE - SECLORISNG CHOLANGITIS	UGIE - ESOPHAGEAL VARIX & PORTAL HYPERTENSION	-	-	-	BENIGN	BENIGN
4	964449	1	PRIMARY SCLEROSING CHOLANGITIS WITH CHOLEDOCOLITHIASIS	DISTAL CBD STRICTURE	NEGATIVE FOR M - CELLS	-	-	BENIGN	BENIGN
5	970416	0	DUODENAL MALIGNANCY WITH INFILTRATION OF PD GROOVE & HEAD OF PANCREAS	-	-	-	ADENOCARCINOMA PANCREATICOBILIARY ORIGIN	MALIGNANT	MALIGNANT
6	978894	1	DISTAL CBD STRICTURE WITH OBSTRUCTIVE BILIOPATHY & F/O CHRONIC CHOLECYSTITIS	TIGHT STRICTURE DISTAL CBD (AMPULLA)	benign	-	-	BENIGN	BENIGN
7	972228	1	PERICHOLECYSTIC LN CAUSING STRICTURE OF CHD	TIGHT STRICTURE AT HILUM	-	-	HILAR MASS- NEUROENDOCRINE CA	MALIGNANT	MALIGNANT
8	988691	1	SHORT BENIGN STRICTURE INTRAPANCREATIC CBD WITH CHOLEDOCOLITHIASIS	DISTAL CBD STRICTURE- BENIGN	NEGATIVE FOR M CELLS	-	-	BENIGN	BENIGN
9	964504	1	P/O CHOLECYSTECTOMY WITH SHORT SEGMENT STRICTURE SUPRAPANCREATIC CBD	-	-	THICKENING OF THE MID CBD	-	BENIGN	BENIGN
10	985794	1	CA GB WITH STRICTURE OF CHD & PRIMARY CONFLUENCE	CHD & CBD STRICTURE	-	-	ADENOCARCINOMA GB	MALIGNANT	MALIGNANT
11	995420	1	CHRONIC PANCREATITIS WITH STRICTURE OF INTRAPANCREATIC CBD AND MPD IN THE HEAD REGION AND OBSTRUCTIVE BILIOPATHY	STRICTURE DISTAL CBD WITH OBSTRUCTIVE BILIOPATHY	-	-	PERIAMPULLARY BIOPSY - CHRONIC INFLAMMATORY CELLS	BENIGN	BENIGN
12	995044	1	POST CHOLECYSTECTOMY - BENIGN STRICTURE CHD & PROXIMAL CBD	-	-	MILD NARROWING OF PROXIMAL CBD - benign	-	BENIGN	BENIGN
13	965874	0	ADVANCED PANCREATIC DUCTAL CARCINOMA WITH STRICTURE OF MID CBD AND MPD	MID CBD STRICTURE	-	-	ADENOCARCINOMA PANCREAS	MALIGNNAT	MALIGNANT
14	992256	1	CHRONIC PANCREATITIS WITH STRICTURE OF MID DISTAL CBD STRICTURE WITH OBSTRUCTIVE BILIOPATHY	DISTAL CBD STRICTURE	NOT E/O MALIGNANT CELLS	-	-	BENIGN	BENIGN
15	85939	1	CHRONIC PANCREATITIS - STIRCTURE INTRAPANCREATIC CBD WITH OBSTRUCTIVE BILIOPATHY	DISTAL CBD STRICTURE- BENIGN	-	-	DUODENAL BIOPSY - INFLAMMATORY CELLS	BENIGN	BENIGN
16	1026544	1	ASYMMETRICAL GB THICKENING INVOLVING CHD AND PROXIMAL CBD	-	-	-	ADENOCARCINOMA GB	MALIGNANT	MALIGNANT
17	966581	1	DISTAL CBD STRICTURE WITH CHRONIC CALCULOUS CHOLECYSTITIS	DISTAL CBD STRICTURE	-	-	PERIAMPULLARY BIOPSY- CHRONIC INFLAMMATORY CELLS	BENIGN	BENIGN
18	1037025	1	ADVANCED GB MALIGNANCY WITH NECROTIC PERIPORTAL DEPOSIT WITH STRICTURE OF INTRAPANCREATIC CBD	STRICTURE INTRAPANCREATIC CBD	-	-	METASTATIC DEPOSITS	MALIGNANT	MALIGNANT
19	1060215	0	MALIGNANT MASS HEAD OF PANCREAS WITH EXTENSION ALONG CBD & OBSTRUCTIVE BILIOPATHY	DISTAL CBD STRICTURE	CBD BRUSHINGS- POSITIVE FOR MALIGNANCY	-	-	MALIGNANT	MALIGNANT
20	1072308	1	STRICTURE OF CBD IN DISTAL MOST PART	STRICTURE JUST NEAR AMPULLA	NEGATIVE FOR MALIGNANCY	-	-	BENIGN	BENIGN
21	984859	1	HEPATIC HILAR MASS INVOLVING PRIMARY CONFLUENCE	-	-	-	HILAR MASS- ADENOCARCINOMATOUS DEPOSIT	MALIGNANT	MALIGNANT
22	1056497	1	INTRAPANCREATIC CBD STRICTURE WITH CHOLEDOCOLITHIASIS WITH F/O ACUTE PANCREATITIS	STRICTURE INTRAPANCREATIC CBD	NEGATIVE FOR MALIGNANT CELLS	-	-	BENIGN	BENIGN
23	1086567	1	CHRONIC ATROPHIC PANCREATITIS-PARADUODENAL PANCREATITIS WITH DISTAL CBD STRICTURE AND OBSTRUCTIVE BILIOPATHY	STRICTURE DISTAL CBD	-	-	-	BENIGN	BENIGN
24	395718	0	CHRONIC CALCIFIC PANCREATITIS WITH STRICTURE INTRAPANCREATIC CBD WITH DOUBLE DUCT SIGN	TIGHT STRICTURE DISTAL CBD	BRUSHINGS- POSITIVE FOR MALIGNANCY	-	-	BENIGN	MALIGNANT
25	954689	1	HIV CHOLANGIOPATHY-PSEUDOSCLEORISNG CHOLANGITIS	INTRAHEPATIC DILATATION & STRICTURING	NEGATIVE FOR M CELLS	-	-	BENIGN	BENIGN
26	525558	1	FOCAL IHBRD LATERAL SEGMENT LEFT LOBE - ORIENTAL CHOLANGITIS	DILATED LEFT SIDED BILIARY RADICALS	NA	NA	NA	BENIGN	BENIGN
27	969237	1	SECONDARY SCLEROSING CHOLANGITIS? RPC	STRICTURE PROXIMAL COMMON DUCT	-	-	-	BENIGN	BENIGN
28	1155660	1	GB MALIGNANCY INFILTRATING HEPATIC HILUM & CHD WITH OBSTRUCTIVE BILIOPATHY	-	-	-	ADENOCARCINOMA GB	MALIGNANT	MALIGNANT
29	1163861	1	POST CHOLECYSTECTOMY- BISMUTH TYPE 1 CBD STRICTURE	STRICTURE SPROXIMAL & MID CBD- BENIGN	-	-	-	BENIGN	BENIGN
30	1130519	1	AUTOIMMUNE PANCREATITIS WITH INTRAPANCREATIC CBD STRICTURE	DISTAL CBD STRICTURE	NEGATIVE FOR MALIGNANT CELLS	-	-	BENIGN	BENIGN
31	1176296	1	ACUTE ON CHRONIC PANCRREATITIS WITH STRICTURE INTRAPANCREATIC CBD	SMALL STRICTURE INTRAPANCREATIC CBD WITH OBSTRUCTIVE BILIOPATHY	-	-	PERIAMPULLARY BIOPSY- INFLAMMATORY	BENGIN	BENIGN
32	183774	1	POST CHOLECYSTECTOMY- CHD STRICTURE WITH OBSTRUTIVE BILIOPATHY	CBD STRICTURE - BENIGN	-	-	-	BENIGN	BENIGN
33	1177138	1	BENIGN STRICTURE INTRAPACREATIC CBD	DISTAL CBD STRICTURE- BENIGN	NEGATIVE FOR MALIGNANT CELLS	-	-	BENIGN	BENIGN

S. No	MRD	Name	Age	SBilT (mg/dl)	SBilD (mg/dl)	AST	ALT	ALP	Amylase	Lipase	Ca19-9	Lesion hepatic segment	HILAR INVOLVEMENT	GB Masslesion	Postop	GB Wallthickness	RHD calibre	LHD calibre	CHD calibre	CBD calibre	IHBRdilatation	Site of stricture	Number of stricture	Symmetry	Wall thickness	Wall enhancement	Narrowing	Signalintensity	Length stricture	Diffusion restriction stricture	Luminal contents stricture
34	1199723	J.S	45 YEAR	1.02	0.76	46	56	310	-	-	-	-	NO	1	Yes	-	5.8	6.2	10	-	1	3	0	1	1	-	0	1	15	2	-
35	1201191	K.S	50 YEAR	5.6	4.6	98	56	546	-	-	-	-	NO	1	No	0	15	14.5	18	20	1	4	0	0	5.3	-	0	0	15	1	2
36	1212125	A.S	64 YEAR	0.89	0.72	45	56	254	890	1053	-	-	NO	1	No	0	11	11.2	13	12.5	1	4	0	-	0.7	-	0	2	10	2	2
37	1234912	RO	63 YEAR	0.8	0.7	56	75	189	-	-	-	-	NO	1	No	0	4	3.6	5.1	5.6	1	4	0	1	0.7	-	0	1	8	2	2
38	1236721	H.S	36 YEAR	1.08	0.98	96	124	368	-	-	-	-	NO	-	No	-	12.5	14	15.2	14	1	4	0	1	0.6	-	1	1	7	2	2
39	1240707	M.S	37 YEAR	0.9	0.7	98	106	312	-	-	-	-	NO	-	Yes	-	13	14	14.2	15.5	1	4	0	1	1	-	1	1	18	2	1
40	1251477	K.B	89 YEAR	2.4	1.9	98	125	651	-	-	-	-	NO	1	No	0	9.9	10	12.1	-	1	3	0	0	2.2	0	0	1	18	2	2
41	511969	N.S	55 YEAR	3.4	2.7	123	241	341	-	-	-	AT HILUM	YES	1	No	0	6	6.5	12	-	1	3	0	0	2.5	-	0	1	19	1	2
42	933414	JY	51 YEAR	0.9	0.8	45	36	398	-	-	156	-	NO	-	Yes	-	5.9	6.1	14	11.3	1	4	0	0	2.7	0	0	0	12	1	2
43	1291505	SH	45 YEAR	0.7	0.6	78	98	612	-	-	123	-	NO	1	No	0	9.5	11	20	16	1	4	0	0	4	-	0	1	15	1	2
44	351122	KA	54 YEAR	9.8	7.8	145	189	459	-	-	124	-	Yes	-	Yes	-	5	5.2	8	-	1	2	0	0	2.6	-	0	0	8.9	1	2
45	1297758	R.S	75 YEAR	15.4	13.4	285	356	985	-	-	-	-	YES	0	No	1	18	14	14	-	1	2	0	0	3.5	-	0	0	33	1	2
46	1297129	BA	57 YEAR	0.8	0.74	45	56	241	-	-	5.6	-	NO	-	Yes	-	7	8	9.7	14	1	4	0	1	0.7	-	1	1	10.7	2	2
47	1324995	R.K	47 YR	14.2	13.5	245	265	545	-	-	214	4,8	NO	1	No	0	5.6	6	12.5	11.1	1	4	0	0	3.7	-	0	0	15.4	1	2
48	1323994	K.S	51 YR	1.9	1.07	106	125	286	-	-	4.1	-	NO	1	No	0	4.2	5.1	10	8.7	1	4	0	1	0.8	-	1	1	6.7	2	2
49	877403	B.S	56 YR	12.1	11.4	569	574	745	-	-	2.3	5	Yes	0	No	1	11.1	15.7	-	-	1	2	0	0	4.1	-	0	1	-	1	2
50	1325825	R.A	49 YR	2.1	1.8	122	135	265	-	-	-	-	YES	1	No	0	3.9	4	-	-	1	1	0	1	0.3	1	0	1	-	2	2
51	101939	PR	28 YR	0.78	0.64	42	56	297	-	-	-	-	NO	1	No	0	5	7	9	10	1	4	0	1	0.8	1	0	1	9.8	2	2
52	115876	S.K	57 YEAR	2.3	2	145	167	356	-	-	-	-	NO	1	No	0	-	-	7.4	-	1	0,1,4	1	1	0.9	-	0	1	7	2	0
53	487565	S.S	61 YEAR	4.5	3.6	85	122	423	-	-	12.1	-	NO	1	No	0	18.3	19.2	23.7	20.1	1	4	0	0	3.4	0	0	0	16	1	1
54	547869	S.D	79 YEAR	4.1	3.2	256	278	345	-	-	6.2	-	NO	1	No	0	17.5	19.4	21	19.3	1	4	0	1	2.9	0	0	0	4	2	2

S. No	MRD	Focal lesion pancreatic head	Imaging diagnosis	Endoscopic findings	Cytology findings	Operative findings	Histopathology	FINAL IMAGING DIAGNOSIS	Final correlation
34	1199723	1	POST CHOLECYSTECTOMY - SUPRAPANCREATIC CBD STRICTURE	-	-	FOCAL SHORT THICKENIG OF PROXIMAL CBD	-	BENIGN	BENIGN
35	1201191	1	POSSIBILITY OF MALIGNANT STRICTURE INTRAPANCREATIC CBD	DISTAL CBD STRICTURE	SUSPICIOUS FOR MALIGNANCY	-	-	MALIGNANT	MALIGNANT
36	1212125	1	NECROTISING PANCREATITIS WITH STRICTURE INTRAPANCREATIC CBD	STRICTURE DISTAL CBD - BENIGN	-	-	-	BENIGN	BENIGN
37	1234912	1	PANCREATITIS WITH STRICTURE INTRAPANCREATIC CBD & RESULTANT OBSTRUCTIVE BILIOPATHY	SHORT STRICTURE DISTAL CBD	NA	NA	NA	BENIGN	BENIGN
38	1236721	1	GROOVE PANCREATITIS WITH LOW CBD STRICTURE	COULD NOT BE ATTEMPTED	NEG FOR M-CELLS	-	-	BENIGN	BENIGN
39	1240707	1	LONG SEGMENT STRICTURE INTRAPANCREATIC CBD	STRICTURE DISTAL CBD	NEG FOR M-CELLS	-	-	BENIGN	BENIGN
40	1251477	1	MID CBD STRICTURE WITH OBSTRUCTIVE BILIOPATHY & RETROPERITONEAL LYMPHADENOPATHY- MALIGNANT	CHOLANGITIS	-	-	-	MALIGNANT	BENIGN
41	511969	1	K/C/O HCC - SUPRAPANCREATIC CBD STRICTURE - SECONDARY TO PORTOCAVAL LYMPPHADENOPATHY	PATIENT NOT FIT FOR PROCEDURE	-	-	-	MALIGNANT	MALIGNANT
42	933414	0	ILL-DEFINED MASS HEAD OF PANCREAS WITH DOUBLE DUCT SIGN- ?PANCREATIC MALIGNANCY	LOWER CBD STRICTURE	-	-	ADENOCARCINOMA PANCRREAS	MALIGNANT	MALIGNANT
43	1291505	0	MALIGNANT CBD STRICTURE IN INTRAPANCREATIC SEGMENT	-	-	WHIPPLES PROCEDURE	MALIGNANT	MALIGNANT	MALIGNANT
44	351122	1	SOFT TISSUE CAUSING STRICTURE OF PROXIMAL CHD & EXTENDING ALONG RIGHT & LEFT DUCT? MALIGNANT	HILAR STRICTURE & IRREGULAR MUCOSA AT HILUM	-	-	INFLAMMATORY	MALIGNANT	BENIGN
45	1297758	1	GB NECK MALIGNANCY WITH STRICTURE OF CHD & PROXIMAL CBD	CHD STRICTURE	-	-	ADENOCARCINOMA GB	MALIGNANT	MALIGNANT
46	1297129	1	CHRONIC SEVERE PANCREATITIS WITH STRICTURE INTRAPANCREATIC CBD	DISTAL MOST CBD STRICTURE	NEGATIVE FOR MALIGNANT CELLS	-	-	BENIGN	BENIGN
47	1324995	0	CARCINOMA HEAD OF PANCREAS WITH STRICTURE INTRAPANCREATIC CBD	-	-	-	ADENOCARCINOMA PANCREAS	MALIGNANT	MALIGNANT
48	1323994	1	CHRONIC PANCREATITIS WITH STRICTURE INTRAPANCREATIC CBD	-	-	-	HEAD OF PANCREAS- CHRONIC PANCREATITIS	BENIGN	BENIGN
49	877403	-	ADVANCED GB MALIGNANCY WITH INFILTRATION OF CHD	HILAR BLOCK	NEGATIVE FOR MALIGNANT CELLS	-	-	MALIGNANT	MALIGNANT
50	1325825	1	OBSTRUCTIVE STRICTURE AT PRIMARY CONFLUENCE WITH SOFT TISSUE AT HILUM- BENIGN	HILAR STRICTURE	NEGATIVE FOR M- CELLS	-	-	BENIGN	BENIGN
51	101939	1	SMOOTH STRICTURE INTRAPANCREATIC CBD	DISTAL CBD STRICTURE- BENIGN	-	-	INFLAMMATORY	BENIGN	BENIGN
52	115876	1	RECURRENT PYOGENIC CHOLANGITIS WITH STRICTURE LOWER END CBD	MID CBD STRICTURE	NEGATIVE FOR M-CELLS	-	-	BENIGN	BENIGN
53	487565	0	PERIAMPULLARY CARCINOMA WITH DOUBLE DUCT SIGN- ADENOCARCINOMA	DISTAL CBD STRICTURE WITH PERIAMPULLARY INFILTRATION	ATYPICAL CELLS- SUSPICIOUS FOR MALIGNANCY	-	-	MALIGNANT	MALIGNANT
54	547869	1	PERIAMPULLARY CARCINOMA WITH DOUBLE DUCT SIGN	AMPULLARY STONES	-	-	INFLAMMATORY	MALIGNANT	BENIGN

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The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Angie Garg**, a student of your college for **MD Radio-diagnosis** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Role of mr imaging and mr cholangiopancreaticography in characterization of bile duct stricture.

Supervisor
Dr. Kavita Saggar
Prof. & Head,
Dept. of Radio-diagnosis,
DMCH, Ludhiana.

Co-Supervisor

Dr. Kamini Gupta
Prof.,
Dept. of Radio-diagnosis,
DMCH, Ludhiana.

The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

S P Singh

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

111. If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.

112. The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.

ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN

PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MD

In

RADIODIAGNOSIS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

March, 2021

Dr. Angie Garg

DEPARTMENT OF RADIODIAGNOSIS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE
For the degree of	MD (Radiodiagnosis)
Name of the candidate	Dr. Angie Garg
Supervisor	Dr. Kavita Saggar, Professor and Head, Department of Radiodiagnosis, DMCH, Ludhiana
Co-supervisor(s)	Dr. Kamini Gupta, Professor, Department of Radiodiagnosis, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Biliary stricture is a fixed narrowing of a segment of the bile duct that results in proximal biliary dilatation and clinical features of obstructive jaundice. A wide spectrum of hepatobiliary and pancreatic diseases, both benign and malignant, can result in the development of biliary stricture. It is important to differentiate malignant from benign stricture, since their treatment and prognosis vary. Contrast enhanced MR imaging with MR cholangiopancreatography offers the most comprehensive evaluation as it helps accurately determine the status of the biliary ductal system by identifying the exact site of the obstruction and the length of the stricture. It helps determine whether a patient should undergo percutaneous transhepatic cholangiography with an antegrade stent placement or retrograde intervention thereby avoiding unnecessary risks associated with multiple invasive procedures. Cross-sectional MR imaging is necessary to identify the organ of tumor origin, define the tumor margins, and determine the stage of disease. Hence, it helps evaluate the appropriateness of curative surgical therapy versus palliative drainage procedures.

Aim of Study: 1) To study the spectrum of biliary stricture.
2)To differentiate benign from malignant bile duct stricture using MR imaging and MRCP. 3)To correlate the imaging findings with endoscopic, ERCP, EUS, surgical findings, cytology or histopathology wherever possible.

Materials & methods: A prospective study of patients undergoing MRI and MRCP for suspected biliary obstruction, at the Department of Radiodiagnosis, Dayanand Medical College & Hospital, during a one year period. The patients will be imaged using MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Seimens, Germany.

Clinical Significance: The preoperative characterization of bile duct stricture is essential for planning surgical strategy, the feasibility of conservative treatment and avoiding unnecessary surgical interventions. Imaging with MRI and MRCP may therefore help decide appropriate treatment strategy.

Keywords: Biliary stricture, MRCP

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE"** exist in the Department of Radiodiagnosis, DMC&H, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

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Co-Supervisor

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Professor
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Head of the Department

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Place : DMCH

Date : 8/3/21

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

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Department	Radiodiagnosis
Topic of Thesis	ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE
Likely date of appearing in PG examination	June 2023
Date of enrollment	24TH JUNE 2020
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Approved: Yes / No

Dr. Sandeep Puri
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Approved: Yes / ~~No~~

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BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	Dr. Angie Garg H.NO. 5255, Street no.2, Malviya Nagar, Bathinda, Punjab.
2	NAME OF THE INSTITUTE	Dayanand Medical College& Hospital, Ludhiana.
3	COURSE OF STUDY AND SUBJECT	M.D. Radiodiagnosis
4	DATE OF ADMISSION OF COURSE	24/06/2020
5	TITLE OF THE TOPIC	Role of MR imaging and MR cholangiopancreaticography in Characterization of Bile Duct Stricture

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Differentiation of benign from malignant biliary stricture based on imaging has been one of the challenges for the radiologist. Benign biliary strictures have various origins, each with a different natural history and each demonstrating a different response to treatment. Iatrogenic causes, such as cholecystectomy and orthotopic liver transplantation, are the most common. Postoperative biliary strictures can be further classified as anastomotic or non-anastomotic. Other causes include inflammatory, autoimmune or immunoglobulin G4–related cholangiopathy, radiation-induced sclerosing cholangitis, ischemia, and infections like HIV induced cholangiopathy, etc. Malignant biliary strictures usually result from local malignancy, most commonly cholangiocarcinoma, pancreatic adenocarcinoma, liver metastases, hepatocellular carcinoma, ampullary carcinoma, or gallbladder adenocarcinoma. Other causes can include lymphoma and metastasis to the regional lymph nodes.

In a suspected case of biliary obstruction with clinical and laboratory findings suggestive of obstructive jaundice, the main aim of the radiologist is to confirm the presence of obstruction and to identify its location, extent and probable cause.

For the imaging diagnosis of biliary strictures, invasive imaging modalities, such as percutaneous transhepatic cholangiography (PTHC) and endoscopic retrograde cholangiopancreaticography (ERCP) are usually preceded by noninvasive options to diagnose and characterize biliary strictures. These options, include ultrasonography (US), multidetector CT (MDCT) and MRI with MR cholangiopancreatography.

Magnetic resonance cholangiopancreatography (MRCP) has become an important diagnostic procedure in evaluation of pancreaticobiliary ductal abnormalities [1]. MRCP offers the advantage of noninvasive imaging without the risk of any procedure-related complications, allows evaluation of the biliary system beyond a tight stricture, and allows

assessment of the hepatic parenchyma and other intraabdominal viscera. Magnetic resonance imaging is increasingly being used for cross-sectional imaging of the abdomen in patients with biliary obstruction.

It also has distinct advantage of being able to evaluate the biliary enteric anastomosis in the immediate postoperative period. MRCP is highly sensitive for the diagnosis of biliary strictures and is the imaging modality of choice for identifying the level of obstruction. This modality can also delineate recurrence of the primary pathology (e.g., primary sclerosing cholangitis) and complications associated with various pathologic conditions causing biliary stricture such as bile leak and biloma formation following iatrogenic biliary stricture, biliary stasis leading to stone formation and help evaluate progression of benign disease to a malignant condition as seen in cases of primary sclerosing cholangitis.

MRCP is of advantage in identifying distal causes of CBD obstruction as sonography has limitations in the evaluation of the distal CBD which may be obscured by bowel gas and demonstration of biliary strictures. The advantages of MRCP over MDCT include the lack of ionizing radiation, along with the ability to provide high quality cholangiograms that can determine the location and extent of biliary strictures and help guide endoscopic therapy, particularly when ERCP is indicated [2]. Traditionally, endoscopic retrograde cholangiopancreatography (ERCP) has been used to diagnose suspected biliary obstruction, but this technique is invasive [3,4]. Moreover, ERCP only allows the intraluminal assessment of bile duct while, evaluation of the extraluminal soft tissue component is not possible. Contrary to ERCP, 3D-MRCP is a non-invasive diagnostic technique that can depict the anatomy of entire biliary tree, including the obstructed segment as well as the proximal and distal bile ducts. Additionally, more detailed information about the biliary anatomy and morphology of stricture can be better visualized with 3D-MRCP images [5]. Due to the risk of acute pancreatitis associated with ERCP, especially in low volume centers,

MRCP is preferred for the initial evaluation of patients with biliary stricture. The ability to obtain a cholangiogram without injection of contrast into the biliary tree is significant, since the injection of contrast medium can result in hard-to-treat cholangitis in patients in whom adequate biliary drainage cannot be achieved during ERCP[6].

In MRCP, the basic principle is that body fluids like bile and pancreatic secretions, have high signal intensity on heavily T2 –weighted magnetic resonance sequences which appear bright, while the background tissues generate little signal and appear dark. MRCP is usually performed with heavily T2W sequences by using fast spin echo or SSFSE (Single Shot Fast Spin Echo) technique and both a thick collimation (single section) and thin collimation (multisection) technique with a torso phased array coil. The coronal plane is used to provide a cholangiographic display and the axial plane is used to evaluate the pancreatic duct and CBD[7].

MRCP has a high reported sensitivity and specificity, similar to that of ERCP, for assessing the level and morphology of biliary stricture[8,9]. MRCP can also help in differentiating malignant from benign stricture, with a reported sensitivity of 38–90% and specificity of 70–85% [10,11]. The combination of different imaging sequences influence the diagnostic capability of MR examination. Conventional T1- and T2-weighted images allow evaluation of extraductal soft tissue, which may increase the diagnostic accuracy by demonstrating extension of tumor, lymphadenopathy, or metastasis in addition to depiction of tumor itself[12].

The purpose of this study is to determine the value of conventional T1- and T2-weighted images and gadolinium-enhanced MR images with MRCP images in differentiation of benign from malignant biliary stricture.

6.2 REVIEW OF LITERATURE

It is frequently challenging to make the correct diagnosis in patients with biliary strictures. This is particularly important as errors may have disastrous consequences. Benign-appearing strictures treated with stents may later be revealed to be malignant and unnecessary surgery for benign strictures carries a high morbidity rate. The diagnostic approach for identification of cause of biliary stricture include laboratory parameters, imaging modalities, cytological and histopathological confirmation.

Conjugated hyperbilirubinemia with cholestatic pattern of liver chemistry should be looked for in patients with biliary strictures. Patients with obstructive jaundice have a higher likelihood of malignancy than those with normal serum bilirubin levels. Serum CA19-9 and carcinoembryonic antigen (CEA) are commonly used in clinical practice in patients with suspected hepatobiliary malignancy. Serum CA19-9 levels above 37U/mL have a sensitivity of approximately 74% in patients with biliary malignancy but the specificity for diagnosing malignancy is unacceptably low and elevated serum CEA level has also been shown to have a sensitivity of 33–68% and specificity of 79–95%, for cholangiocarcinoma[13]. Other tumor markers studied for diagnosis of cholangiocarcinoma include transthyretin (TTR), interleukin-6 (IL-6), mucin-5AC (MUC5AC) and matrix metalloproteinase-7 (MMP-7)[14] . Their utility in clinical decision-making for management of patients with indeterminate biliary strictures is rather limited and they are not recommended for routine clinical use.

Trans-abdominal ultrasonography is usually the initial imaging modality used in patients with suspected biliary obstruction. Its advantages include low cost, ready availability, and safety but the diagnostic yield is user-dependent. Ultrasound has very high sensitivity, approaching 100% in detecting intrahepatic biliary dilatation and the level of obstruction, but it has a very low yield for actual detection of strictures or masses[15]. Thus, an abnormal ultrasound or normal ultrasound in

the setting of high clinical suspicion should be followed by higher resolution cross-sectional imaging.

Hintze et al., in 1997 reported that Magnetic reasonance cholangiography (MRC) showed sensitivities (and positive predictive values) of 71% (62%) for recognition of normal bile ducts, 83% (91%) for recognition of dilation, 85% (100%) for recognition of strictures, 77% (91%) for correct stricture location, and 80% (100%) for diagnosing bile duct calculi. In addition, the sensitivity of MRCP in classifying benign and malignant strictures was 50% and 80%, respectively. The statistical values (sensitivity and positive predictive value) for magnetic resonance pancreatography findings were determined for the recognition of normal pancreatic ducts (33% and 50%), recognition of dilation (62% and 100%), recognition of strictures (76% and 87%) and correct location (66% and 100%), diagnosis of benign strictures (87% and 87%) and malignant strictures (60% and 75%) [16].

Lee et al., (1997) in their study found level of obstruction was accurate in 91% (21 of 23) with MR cholangiopancreatography and in 83% (19 of 23) with ERCP (P > .05). The sensitivity, specificity, and accuracy in distinguishing malignant from benign lesions were 81%, 92%, and 87%, respectively, for MR cholangiopancreatography and 71%, 92%, and 83%, respectively, for ERCP [17].

Loopera et al. in their study (2001) using direct cholangiography as the standard of reference, MR cholangiography was adequate in helping predict the Bismuth grade of biliary ductal involvement in 96% (28 of 29) of the patients. MR cholangiography is adequate to define the extent of biliary ductal involvement in patients with malignant hilar and perihilar biliary obstruction and unresectable disease. On the basis of MR cholangiographic findings, a management strategy can be planned, including selection of the most appropriate side for access to the biliary ductal system and the type of biliary drainage required. MR cholangiograms alone can be used for planning palliative percutaneous therapy [9].

In a study conducted by Taylor AC et al, (2002), they prospectively assessed the accuracy of MRCP in 146 patients. They found that the sensitivity, specificity, positive and negative predictive values for MRCP in the diagnosis of Choledocholithiasis were 97.9%, 89.0%, 83.6% and 98.6% respectively. The sensitivity and specificity in diagnosing strictures by MRCP were 100% and 99.1%.They concluded that MRCP is an accurate, noninvasive alternative to ERCP for imaging the biliary tree[18].

In another study, Park et al., (2004) concluded that MR Cholangiopancreatography is comparable to ERCP in differentiating extrahepatic bile duct cholangiocarcinoma from a benign stricture and showed that a lengthy narrowed segment with irregular margins and asymmetric narrowing is suggestive of malignancy .They found that the sensitivity, specificity, and accuracy of MRCP for differentiation of malignant from benign causes of biliary stricture were 81%, 70%, and 76% respectively[19].

Kim et al., (2007) showed that a narrowed segment with the following MR imaging features is more likely to be malignant: hyperenhancement relative to the liver during the portal venous phase, length of over 12 mm, wall thickness greater than 3 mm, indistinct outer margin, luminal irregularity, and asymmetry[20].

Saluja et al., (2007) suggested in their study that malignant strictures were irregular with an asymmetric dilatation because of the nature of involvement of the bile duct by the malignant tumour. They found sensitivity, specificity and diagnostic accuracy of MRCP for biliary obstructive diseases in their study to be 87.5%, 85.3% and 82.7% respectively[10].

In the study by Zidi et al, (2007) MR cholangiography was compared with endoscopic retrograde cholangiopancreatography in patients with hilar strictures; MR cholangiography enabled correct classification of the severity of involvement in 14 (78%) of 18 patients. The usefulness of MR cholangiography in accurate demonstration of the extent of hilar involvement has important implications for therapeutic planning [21].

A study done by Bilgin M et al (2011), to investigate the diagnostic efficacy of dynamic contrast enhanced (MRI) method in patients with bile duct obstruction, it was observed that MRI/MRCP had sensitivity(96%), specificity (100%) and accuracy (96.3%). In determination of presence of level of obstruction (96.7%, 100%, 97.2%), choledocholithiasis (82.3%, 96%, 91.7%) stenosis (95.6%, 91.3%, 94.5%). It was concluded that, MRI/MRCP is a non invasive imaging method with high accuracy rates in the evaluation of obstructive biliary tract pathologies which might replace the diagnostic ERCP[22].

Yu et al (2014), reported that malignant strictures were significantly thicker and longer than the benign strictures and upstream CBD dilatation was larger in the infiltrative cholangiocarcinoma cases than in the benign cases [23].

Katabathina et al., (2014) in their study found that benign strictures showed a short-segment smooth stricture of the CHD or CBD with associated intrahepatic biliary dilatation on MR Cholangiopancreatography [24].

Meena Suthar et al (2015) evaluated 75 cases of obstructive jaundice, out of which, there were 54 benign and 21 malignant cases. Mean age of patients with malignant obstruction was more than benign with slight male preponderance. The diagnostic accuracy of MRCP in differentiating benign from malignant biliary obstructive diseases in correlation with surgical, ERCP and histopathological outcome was 93.3%, sensitivity 85.7%, specificity 96.3%. It was found that irregular, asymmetric and long segment narrowing was more common in malignant stricture [25].

Parashari UC et al., (2015) identified the cause of biliary obstruction in 50 patients found to have biliary obstrucion out of 54 patients. The cause of biliary obstruction was finally identified on the basis of direct cholangiography/surgery/histopathology. In 52 of the 54 patients, MRCP agreed with final diagnosis in identifying the level of block. MRCP agreed with final diagnosis in identifying the cause of

obstruction in 48 of the 54 patients (89%). Sensitivity of MRCP in identifying the level of obstruction in comparison with final diagnosis was 100%, while diagnostic accuracy of MRCP in identifying the level of obstruction in comparison with final diagnosis was 96.29%. The correlation between MRCP and final diagnosis in diagnosing cause of obstruction was 0.95 (Pearson's correlation coefficient, P = 0.017) [26].

6.3 AIMS AND OBJECTIVES OF THE STUDY

1. To study the spectrum of biliary strictures.
2. To differentiate benign from malignant biliary stricture using MR imaging and MRCP.
3. To correlate the imaging findings with endoscopic, ERCP, EUS, surgical findings, cytology or histopathology wherever possible.

7. MATERIALS AND METHODS

7.1 Source of Data

This prospective study will be done on patients undergoing an MRI and MRCP for suspected biliary obstruction, at the Department of Radiodiagnosis, Dayanand Medical College & Hospital, over a period of one year. The patients will be imaged using MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Siemens, Germany.

7.2 METHOD OF COLLECTION OF DATA

Patients having clinical and laboratory parameters suspicious of biliary obstruction and referred to the department of radiodiagnosis will be included in the study. Consent will be obtained from each patient and relevant detailed history will be collected. Before starting MRI study, the procedure will be explained to the patients in his/her vernacular language to allay anxiety and fear.

INCLUSION CRITERIA:

1. All patients found to have biliary stricture on MRI and MRCP.

EXCLUSION CRITERIA:

- Patients with prior history of biliary surgery except cholecystectomy.
- Anyone who is unwilling to participate in the study.
- Any contraindications to contrast administration (GFR < 30ml/min).

MR imaging technique

All patients will undergo a multiplanar, multisequential MR imaging of upper abdomen on a MAGNETOM SKYRA 48 Channel 3 Tesla MRI Scanner by Siemens, Germany.

Following MR imaging sequences to be included:

1. T2 haste axial
2. T2 haste fat sat axial
3. T2 haste coronal
4. T2 trufi axial
5. T1 VIBE in-out phase axial

6. Diffusion Weighted Imaging (DWI) in axial plane acquired at 3 b-values of 50, 400, 800.

7. T2 TSE 3D coronal.

8. Contrast Enhanced MRI

Contrast Enhanced MRI will be performed using three dimensional volume interpolated breath hold examination (3D VIBE) sequence in the transverse plane.

A rapid bolus of 0.1mmol/kg body weight gadobenate dimeglumine will be given through a peripheral vein followed by 10 ml of saline. Images will be acquired in arterial, portal and venous phase. Delayed phase images (1 hour after contrast administration) will be acquired if indicated.

Image and data analysis

The biliary tree will be evaluated for its calibre and presence of stricture/strictures. The following features of biliary stricture will be evaluated :

Site of stricture, number of strictures, wall thickness, wall signal, wall enhancement relative to liver parenchyma, length of stricture, diffusion pattern and luminal contents.

Duration of Study: one year from 1st March 2021 to 28th Feb 2022.

Outcome: Analysing the MRCP findings and classifying the biliary stricture into benign and malignant and their correlation with the endoscopic, EUS, ERCP, surgical, cytology or histopathological findings wherever possible.

	TR	TE	FOV (R)	FOV (P)	SLICE	SLICE THICK	GAP	FLIP ANGLE	FAT SAT	MATRIX	FLOW COMP	PHASE ENC	ORIENTATION
T1 vibe Fat Sat	3.31 ms	1.3 ms	380 mm	81.3%	72	3 mm	1.1 mm	9^0	SPAIR	182*320	NO	AP	Transverse
T1 vibe In-out phase	4.34 ms	1.34, 2.76 ms	380 mm	81.3%	72	3 mm	1.1 mm	9^0	NONE	182*320	NO	AP	Transverse
T2 haste fat sat	2000 ms	91 ms	350 mm	78.1%	30	5 mm	2.5 mm	160^0	SPAIR	200*320	NO	AP	Transverse
T2 haste traction	2000 ms	91 ms	360 mm	78.1%	30	5 mm	2.5 mm	160^0	NONE	200*320	NO	AP	Transverse
T2 haste coronal	2000 ms	91 ms	350 mm	100%	35	5 mm	0.5 mm	160^0	NONE	288*320	NO	R-L	Coronal
T2 haste thick slab	4500 ms	734 ms	260 mm	100%	1	50 mm	2.5 mm	180^0	FATSAT	314*448	NO	R-L	
Diffusion	5700 ms	48 ms	380 mm	80.6%	30	5 mm	2.5 mm		SPAIR	108*134		AP	Transverse
T2 TSE 3D CORONAL	1600 ms	623 ms	335 mm	100 %	64	1.5 mm	0 mm	180^0	NONE	320*320	NO	R-L	Coronal
T2 haste coronal thin slab	2000 ms	101 ms	350 mm	100%	30	3 mm	0.2 mm	160^0	SPAIR	205*256	NO	R-L	Coronal
T2 Trufi Axial	382 ms	1.68 ms	380 mm	80.5%	30	5 mm	2.5	50^0	None	206*256		AP	Transverse

STATISTICAL ANALYSIS:

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

The study requires MRI and MRCP to be done on patients with suspected biliary obstruction. However, the study does not require any intervention to be done on patients, other humans or animals.

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes, Attached herewith

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diagnosis and clinical profile of patients. Journal of natural science, biology, and medicine. 2015;6:131.

PROFORMA

S.no

1. Patient Particulars:

   a) Name b) Age:

   c) Sex: d) MRD No:

   e) Date of admission: f)Date of discharge:

2. Clinical history:

   a) Presenting complaints

   - Pain abdomen
   - Pain radiating to back
   - Yellowish discoloration of skin and sclera
   - Fever
   - Vomiting
   - Blood in stools
   - Loss of appetite
   - Weight loss

   b) Past medical/ surgical history

3. Laboratory investigations:

   A. Hemogram

   a) Hb% b) TLC

   B. Biochemistry

   a) Serum bilirubin (T) / (D)
   b) AST / ALT
   c) Serum Alkaline phosphatase
   d) Serum Amylase / Lipase
   e) Ca 19-9 IgG4 levels
   f) Others

4. MRI and MRCP FINDINGS:

   A. Liver:

   a) Size b) Outline

   c) Lesions

Signature of Candidate **Signature of Supervisor**

B. Gall bladder:

a) Wall thickness -

b) Luminal contents -

c) Mass lesion -

C. Biliary Ducts:

1. Variable pattern
2. Calibre
   a) RHD b) LHD
   c) CHD d) CBD
3. IHBR dilatation
   Unilobar/ Bilobar

D. Features of strictures:

a) No. of strictures
b) Site of strictures-
c) Wall thickness –
d) Wall signal –
e) Wall enhancement –
f) Length of stricture –
g) Diffusion pattern –
h) Luminal contents –

E. Pancreas :

a) Size -
b) Outline -
c) Focal lesions -
d) Pancreatic duct changes-

F. Lymph nodes -

Signature of Candidate **Signature of Supervisor**

G. Ancillary findings -

5) IMAGING DIAGNOSIS -

6) Endoscopic findings -

7) Cytology findings -

8) EUS -

9) Operative findings -

10) Histopathology -

Final correlation :

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study **"ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य **"ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

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गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"ROLE OF MR IMAGING AND MR CHOLANGIOPANCREATICOGRAPHY IN CHARACTERIZATION OF BILE DUCT STRICTURE" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ